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OF

Manchester.

SKETCH

OF

THE LIFE AND WRITINGS

OF

FERDOOSEE.

By SAMUEL ROBINSON, Esq.

Read before the Society, Dec. 24th, 1819.

THE Literature of any nation, however different its tone and character from that of our own country, or however inferior the works which compose it to those we have been accustomed to regard as the models of a correct taste, is yet a subject of reasonable curiosity, and useful inquiry, inasmuch as it tends to elucidate the natural history and moral character of a portion of the human race. It is hoped therefore that the following sketch of

the life and writings of an ingenious Persian Poet, whose name is, by Oriental scholars, always mentioned with applause, but whose works are but imperfectly known, may not prove altogether uninteresting.

Ferdoosee was born of respectable parents at Tous, a town of Khorasan, a province of Persia, about the middle of the tenth century of our era. He early gave indications of uncommon talents, and most probably enjoyed the advantage of an excellent education, under the best masters of his native place. His ardent love of knowledge attracted the attention of the poet Assedi, who assisted him in his studies, and encouraged his rising genius; and to whose instructions he probably owed his taste for poetry, and that intimate acquaintance with history, which led him afterwards to employ his muse in dignifying and embellishing the popular traditions of his country

At this period, India was governed by the celebrated Mahmood of Ghezni. The poets, whom he patronized, have sung his praises, and ascribed to him the possession of every virtue. He was certainly fond of literature; and learned and ingenious men found a flattering reception at his court. His chief

amusements were poetry and history. He had made large and valuable collections relative to the ancient annals of Persia, and it was his wish to possess a series of heroic poems composed from these materials. This appears to have been a favourite idea with some of the ancient Persian Monarchs. The poet Duqeequee was employed for this purpose by one of the Princes of the race of Sassan; or with more probability, for the accounts vary, of the family of Saman; but he dying by the hand of a slave, after having written only two thousand verses, the design was abandoned. It was afterwards resumed by Mahmood, who wished to add another glory to his reign by procuring the completion of this great work under his own auspices, and he accordingly entertained several poets at his court with this intention.

Ferdoosee, conscious of his genius, was inspired with an ardent desire of enjoying the reputation, which would necessarily follow the successful accomplishment of so arduous an undertaking, and he describes, in animated language, the anxiety which he felt lest another should anticipate him in his purpose. He communicated his plan to his friends at Tous, and, encouraged by them, composed an heroic poem, on the delivery of Persia by

Fereedoon from the tyranny of Zohak. This production was received with universal applause, and introduced the poet to Abu Mansoor, governor of Tous, who urged him to proceed with ardour in the glorious career on which he had entered, and gave him the most flattering assurances of success. Ferdoosee has gratefully owned his obligations to him, and has elegantly sung his praises at the commencement of his poem.

Confident of his strength, Ferdoosee now determined to repair to Ghezni, as to a proper theatre for the display of his genius, and the acquisition of that fame, which he felt that he was destined one day to enjoy. His admission at court was opposed by the rival poets; (1) but he soon established himself in the favor of Mahmood, who allotted to him the honourable task of composing the work which he had projected. Every evening he read to the Sultan what he had written during the day, and Mahmood was so much delighted with these specimens of his performance that, on one occasion, he promised

(1) Jamee, in his Beharistan, relates, that as Unseree, Ferrahee and Usjidee, three of the court poets were sitting together in a garden of the palace, they saw Ferdoosee enter and approach them. Unwilling to admit him into their society, they agreed to repeat each a verse of a tetrastick and to require Ferdoosee to supply the fourth. They accordingly recited each of them one of the following lines.

him a gold deenar for every verse which he should write, but Ferdoosee declined receiving any reward till the whole should be finished.

At length, after the unremitted toil of thirty years, and in the seventieth year of his age, Ferdoosee brought to a conclusion his immortal poem, and presented it to the Sultan. But envy and malice had been too successfully employed in depreciating the value of his labours, and the monarch was induced to bestow upon him a reward very inadequate to his deserts. According to another, and, perhaps, a more probable account, the Vizier, who was his personal enemy, changed the promised sum of gold deenars, into silver ones. Ferdoosee was in the bath when the money was brought to him. The high minded poet could not brook the insult. He divided the paltry present between the boy who bore it, the servant of the bath, and a vender of sherbets, and, retiring to his clo-

> The Moon's mild radiance thy soft looks disclose,
> Thy blooming cheeks might shame the virgin rose,
> Thine eyes' dark glance the cuirass pierces thro',
>
> To which Ferdoosee immediately replied,
>
> Like Poshun's javelin in the fight with Goo.

To add to their mortification, the poets were obliged to confess their ignorance of the story to which he alluded, and which he narrated to them at length.

set, wrote an animated invective against the Sultan, of which the following is a specimen.—(2)

Many Kings have reigned before thee,
Who wore the crown and diadem,
More exalted than thou in rank,
More powerful in armies and treasure;
But they were distinguished by piety and virtue,
Not by rapine and violence:
They did justice to the oppressed;
They were pure of heart and fear'd God;
They sought only a good name,
And, seeking only a good name, their end was happy:
But the king, who is confined in the chains of avarice,
Will be contemptible in the opinion of the wise.

Hadst thou O King! been the son of a king, (3)

(2) It is not a translation of the entire satire. The poem contains besides a vindication of the poet's religious opinions, which were those of the followers of Ali. In the arrangement of the distiches which I have translated, I have been obliged to rely, in part, on my own judgment, as the MSS. differ a good deal in the number and order of the verses.

(3) Mahmood was the son of Sebuchtagin, who was once a slave, but raised himself by his merit to imperial power, and founded the dynasty of the Ghiznavides.

Thou would'st have placed a crown upon my head;
Had thy mother been of noble birth,
Thou would'st have poured down gold upon me;
But the son of a slave will never forget his meanness,
Tho' he should become the father of a line of kings;
From the offspring of impurity expect nothing good,
For the Ethiopian can never change his skin.

Thirty years I toiled incessantly,
And I have made Persia immortal in my verse.
Many illustrious men and heroes,
Of whom I have made distinguished mention,
Men—who were eminent for rank and virtue,
As the noble Jemsheed and the happy Fereedoon,
Who all lay dead in the lapse of ages,
Live again in my writings. (4)

(4) So Horace

Vixere fortes ante Agamemnona
Multi; sed omnes illacrymabiles
Urgentur, ignotique longâ
Nocte, carent quia vate sacro.

Vain was the chief's, the sage's pride!
They had no poet, and they died;
In vain they schem'd, in vain they bled!
They had no poet, and are dead.

POPE.

Thirty years I toiled in pain and anxiety,
That the king might bestow on me riches and honours;
That he might give me independence,
That he might exalt me among the nobles;
At last he opened the door of his treasury,
And dealt me out the pittance of a slave:
The king's present, bestowed on a vender of sherbets,
Procured me a draught of barley-water in the street.

I see that king Mahmood has no greatness of mind;
His soul is averse from all liberality:
The king who is destitute of generosity,
Is not worthy of being praised by the poet.
The vilest of things is better than a king,
Who possesses neither faith, nor piety, nor understanding:
But to exalt the head of the unworthy,
To expect from him any thing good,
Is to scatter dust in your own eyes,
Or nourish a serpent in your bosom.

The tree, which is by nature bitter,
Tho' you should plant it in the garden of Paradise,
And water it from the fountain of Eternity,
And spread about its roots the purest honey,

Would in the end betray its nature,
And would still produce bitter fruit. (5)
If you pass thro' the shop of the seller of amber,
Your garment will retain its odour;
If you enter the forge of the blacksmith,
You will see nothing but blackness:
That evil should proceed from an evil disposition is not wonderful,
For thou canst not wash out the darkness from the night.

Yet, hadst thou had a regard for thine own reputation,
Thou would'st not have injured the poet,
For the injured poet can complain,
And his satire remains for ever.

O King Mahmood, conqueror of regions!
If thou fearest not me, at least fear God;
For in the court of the Most High will I pour out my complaint,
Bowing down, and scattering dust upon my head.

(5) Sir William Jones, in his Poeseos Asiaticæ Commentarii, has quoted and translated a part of this satire. In his copy, these verses are followed by several others, containing paraphrases of the above sentiment. They are not to be found, either in my MS. or in that of the Cheetham Library, and have probably been added by another hand.—*Vide Works. Vol. VI. p. 309. Oct. Ed.*

Having despatched this note, the venerable Poet immediately quitted Ghezni, to avoid the indignation of the Sultan, without even the mere necessaries of a journey. With these however he was secretly provided by his friend Ayazee.

In passing through Kohistan, Nasir ud Deen Mohtassem, the Governor of that country, sent for him, and entertained him with great hospitality. Mohtassem had personal obligations to Mahmood, and finding that it was the intention of Ferdoosee to publish some poems relative to the conduct of the Sultan, he gave him a considerable sum of money, and requested that he would consent to bury them in oblivion. Moved by the kindness and generosity of his protector, Ferdoosee immediately sent him the writings with the following couplets.

My soul is grieved, O my friend!
At the conduct of that unjust king;
For he has blasted the hope of years,
And my complaint is gone up to Heaven.
I had spoken of Mahmood as he deserved;
I fear not the power of any but the Most High;
I had so blacken'd his reputation,
That nothing would ever have effaced the stain:
But Mohtassem commands,

And I know not how to refuse his request:
If there be ought improper in the writings,
Burn them with fire, efface them with water;
For myself, O generous chief!
I pass from this to a better world,
Where God will listen with kindness to my complaint,
And the Giver of all things will do me justice.

From Kohistan Ferdoosee proceeded to Mazinderan, where he spent some time, at the court of a Prince of that country, occupied principally in the revisal and correction of his great work. Still, however, apprehensive of the effects of the Sultan's displeasure, he quitted this place to take refuge at Baghdad, where, as soon as he made himself known, he was received with great distinction by Kader Billah Abassee, the reigning Caliph, at whose court he resided some time in tolerable tranquility. But the fury of Mahmood still pursued him. He wrote to the Caliph to demand Ferdoosee, threatening, in case of a refusal, to lead an army against him. The generous prince, unwilling to give up the man who had sought his protection, and unable to meet the sultan in the field, was reluctantly obliged to dismiss him. He wrote to Mahmood to inform him that Fer-

doosee had withdrawn himself from his protection; and bestowing on the illustrious wanderer a considerable sum of money, he advised him to seek an asylum with the Princes of Yemen. To Tous, however, his native place, not to Yemen, did the poet proceed, where he died, at an advanced age, about the year 1021 of our era.

It is added that Mahmood afterwards relenting in his anger, or perhaps fearing that his conduct would be viewed by posterity in a disgraceful light, (6) sent the stipulated present to Ferdoosee, with a conciliatory letter; that it arrived on the very day Ferdoosee was buried; and that his daughter, to whom it was offered, refused it, saying that she would not accept what had been denied to her Father. In confirmation of the above account, Nasir Khosroo, a physician, relates in his Suffernameh, or book of travels, that when he was at Tous in the year 437 of the Hejira, (A. D. 1045,) he saw a splendid public edifice, newly

(6) Jamee, censuring the injustice of Mahmood, exclaims

Mahmood is dead, and perished his renown,
And of his memory nought but this remains,
He spurned the noblest jewel of his crown,
Nor knew the value of Ferdoosee's strains.

erected, and was told that it was built by order of Mahmood, with the money which the daughter of the poet had refused. (7)

EIGHT hundred years have now elapsed since the publication of Ferdoosee's great work, and it still continues to receive in the East that admiration with which it was hail'd on its first appearance. Whatever indeed be the opinion which European readers may form of it, the Shah-nameh is confessedly the noblest production of Eastern genius, and the applause which has been bestowed upon it, by some liberal and enlightened critics of the Western world, may incline us to believe, that all its merit does not depend upon mere

(7) It is proper to state that some of the circumstances mentioned in the preceding narrative are taken from a MS. account of the life of Ferdoosee, which is prefixed to almost all the copies of his Shah-nameh. It forms a part of the preface to the corrected edition of the Shah-nameh, made by the order of Bayasungher Khan, one of the descendents of the Emperor Timour, and published in the year of the Hejira 829 (A. D. 1425–6.) and may be supposed therefore to contain all that was then known of the poet; but as it is the only detailed account of his life with which I am acquainted, I have no means of ascertaining its perfect authenticity.

oriental prejudices. (8) The assertion indeed that all the literary productions of the East are a tissue of absurd fables, written in a barbarous and bombastic style, without any marks of adherence to truth and nature, is much too loose and general, and proceeds oftentimes from ignorance, or from false principles of judgment. This is not the proper place to institute an enquiry into the existence of a fixed standard of taste, which the varying conclusions of different writers on the subject might almost lead us to suspect; it may not however be improper to observe, that the manners, customs, and opinions of every nation, necessarily impart a peculiar character to its literary productions, and that they ought not to be tried without a reference to those customs and opinions. We read the ancient poets, and enter with enthusiasm into their mythology,—a mythology which was the belief of the people, and identified itself with all their ideas: we are disgusted with the modern poet, who, on the sanction of classical usage, presents to us the same assembly of the Gods, still controlling

(8) Vide Sir William Jones's History of the Persian language. History of the poetry of the Eastern Nations, and Traité sur la Poésie Orientale, Sec. II.—D'Herbelot, à l'art.—Richardson on the Literature and Manners of the Eastern Nations, p. 28.—Malcolm's History of Persia, Vol. II. p. 539.

mortal events. We may sympathize with the despairing Roman, who invokes a Goddess, in whom he believes, to favour his passion; but we accuse of affectation and want of feeling, the modern poet who addresses his vows to the same divinity. To relish thoroughly therefore the literature of any nation, we must endeavour to imbue ourselves with its spirit. If we do this with regard to the works of oriental writers, we may find in them, amidst many extravagant ideas and false thoughts, many things also calculated to delight the fancy, and fill the mind with pleasing images. Why should we disdain to receive from the Persian fables of a Ferdoosee something of the pleasure which we derive from the Gothic mythology of a Tasso, or the Scottish superstitions of a Burns or a Collins?

The Shah-nameh, or book of kings, contains 120,000 lines. It has been called by some an Epic poem; by others a series of Epic poems: but neither with much propriety. It is in truth merely a Historical poem, similar in many respects to our ancient rhyming chronicles, but highly embellished with all the ornaments of poetry and fable. It embraces the whole period of ancient Persian history, commencing with the reign

of Caiumeras, the first king, and ending with that of Yesdejerd, the monarch who governed Persia, when that country was invaded and subjugated by the Arabs. Reign follows reign with undeviating exactness: the natural order of events is rarely disturbed; nor are the incidents of the poem made conducive to the developement of one great action, or to the inculcation of any grand moral truth. Sometimes indeed we may perceive a kind of action complete within itself, but we may generally trace it rather to the unity of some great historical event than to the design of the poet. As a work of art therefore the Shah-nameh is certainly defective; and it is unjust, in endeavouring to estimate its merits, to bring it into comparison with the more regular and classical models of European invention. We might indeed liken it to the Orlando Furioso, to which it bears a considerable resemblance in several respects, particularly in the irregularity of its structure, and the wildness of its incidents; and, still more, in that constant predominance of imagination over judgment, which characterizes the muse of Ariosto. Nor ought we to be so unreasonable as to condemn a performance, because it is not written precisely on the plan which we should most have desired. It is sufficient to establish the ex-

cellence of a work, that the author has done well what it was his intention to do. The plan of Ferdoosee was chalked out for him; and every one, who has read any considerable portion of the Shah-nameh, must be delighted at the admirable manner, in which he has executed the difficult task imposed upon him.

In taking a view of the genius of Ferdoosee as a poet, the object which first strikes us is his amazing power of invention. The materials, from which he composed the historical part of his work, have unfortunately perished, so that we cannot exactly determine how much it owes to this power; but that he possessed it in an extraordinary degree, no one, who is conversant with his writings, can for a moment doubt. The records with which he was furnished consisted, most probably, only of dry facts or fabulous legends. He might draw many of his stories, and the names of some of his principal heroes, from the popular traditions of his country, but the form and character which he has given to the whole must be considered to be the fruit of his own creative genius. On a very narrow basis, he has founded a structure, irregular indeed in its design, and unequal in its exe-

cution, but of so vast proportions, and, in particular parts, so highly finished, that we cannot contemplate it without sentiments of astonishment and admiration. He has skillfully interwoven into his poem the whole range of Persian enchantment and fable, and has, at the same time, enlivened his narrative with so many agreeable episodes and adventures that the attention of the reader is constantly diverted, and he is led on, generally without weariness or effort, through the pages of this stupendous performance. Whoever indeed considers the immense length of the work, the copiousness of the subject, and the variety which reigns throughout it, cannot fail to have a high opinion of the exuberance of the Poet's fancy and the uncommon fertility of his ideas.

The originality of Ferdoosee is undoubted. He had no one before him from whom to copy, and his excellencies are therefore wholly his own. His conceptions are in general lively and vigorous; his thoughts bold and forcible; his figures striking and animated. Every where, throughout his poem, we feel the glow of a rich and ardent imagination. Ferdoosee has made but little use of Mythology. Events are generally brought about without

the intervention of super-human agency. To some this may appear a defect. Perhaps the extraordinary qualities with which the Poet invests some of his heroes, as it places us in some sort among another race of beings, may render the use of machinery an object of less importance.

The minute and perfect delineation of Character is rarely the distinguishing excellence of very early poets. In a nation emerging out of barbarism, the characters of men are in general sufficiently original and poetical, but they must be viewed in classes rather than as individuals. Those slighter traits which distinguish one individual from another of the same class, can be called into existence only with the progress of refinement, or are too evanescent to be observed till men begin to be brought into closer contact by the influence of society. Homer, great as he is in this respect, is inferior to Tasso in the fine discrimination of characters marked by the same general qualities. Ferdoosee is still inferior to Homer. Yet the characters of the Shahnameh are, on the whole, well supported, and varied and contrasted with considerable skill; and there are a few, which are touched with a delicacy and beauty hardly to have

been expected in a poet of his age and country.

The descriptions of Ferdoosee are rich and varied, and it is in the descriptive parts of his poem that he will probably be thought by many to have displayed his happiest talent. Born in the favoured country of fiction and romance; familiar from an early period of his life with the magnificence of the most powerful and splendid court of Asia; it is not to be doubted that his mind must have been early impressed with scenes and stories, and embued with associations, admirably calculated to make a deep impression on a naturally ardent and lively imagination. His battles are painted in bold and lively colours; and when we read of pomps and processions, and royal banquets, and gardens and palaces, adorned with every thing which wealth and power united can command, we have no difficulty in following the poet in his wildest flights, and are scarcely disposed to criticise his descriptions as too warm, or the language in which they are conveyed as too luxuriant.

His narratives are generally spirited and poetical. His sentiments just and noble. His touches of real passion often appeal forcibly

to the heart, and convince us that the Poet felt strongly the emotions which he describes. The dignity and beauty of the moral reflections, which are liberally scattered throughout the work, would alone render it highly valuable. (9)

The diction of Ferdoosee is soft and elegant, but at the same time bold and animated. His versification smooth and polished. (10) His style ea y and natural. He is distinguished from all other Persian poets by that inimitable simplicity which is almost always the accompaniment of the highest order of genius. When his simplicity is thus spoken of, it is not meant to be understood that many instances of bad taste may not be found in

(9) The following fine passage may be selected as an example.

One thou exaltest, and givest him dominion,
Another thou castest as food to the fishes;
One thou enrichest with treasure like Caroon,
Another thou feedest with the bread of affliction:
Nor is that a proof of thy love, nor this of thy hatred,
For thou, the Creator of the world, knowest what is fit;
Thou assignest to each man his high or low estate,
And how shall I describe thee? THOU ART, WHAT THOU ART!

(10) The Shah-nameh is written in the purest dialect of the old Persian, before it had received any admixture of Arabic words. Mohammed, who admired it for its extreme sweetness, used to declare that it would be the language of Paradise.

his writings, but still they shew a wonderful freedom from those meretricious ornaments and puerile conceits, and those affected forms of expression, which disgrace the best compositions of his country.

It does not consist with the object of the present sketch to enter into a detail of the faults of Ferdoosee. The Shah-nameh, admirable as it is in many respects, is still a Persian poem, and the candour of European critics must be called upon to make large allowances for its imperfections. In so long a performance it is not wonderful that there are passages which are tedious, and that the action sometimes languishes. The minuteness of the Poet sometimes degenerates into feebleness, and occasionally becomes ridiculous. He has many weak and faulty verses. His figures are sometimes too gigantic or far fetched; his thoughts often forced and unnatural. His language occasionally is too inflated, and sometimes borders on extravagance. But these and other blemishes may be traced rather to the age and country in which he lived than to any want of genius. "Had he been born in Europe," says the laborious editor of the printed edition of the Shah-nameh, "he might have left a work

more to our taste, but, born any where, he could not fail to impress on his writings the stamp and character of his extraordinary powers. These are accordingly acknowledged and felt throughout the whole extent of the Moohummudan world, and will, I doubt not, be recognized in Europe, amidst all the vices of a Persian taste, with which indeed he is much less tinctured, in my opinion, than any Persian poet I ever read." (11)

In fine, Ferdoosee, in whatever light we contemplate him, was certainly a remarkable man; and if genius be estimated, not by the absolute height to which it rises in the scale of excellence, but by the degree which it attains by its own unassisted efforts, then the genius of Ferdoosee may be thought to rival that of some who have produced more finished works, amidst more favourable opportunities of approaching towards perfection. In the history of Persian literature, at least, the Shah-nameh, must ever be regarded as a

(11) Preface, p. 3. to the excellent edition of the Shah-nameh by Mr. Lumsden, of which the first volume only has yet appeared, published at Calcutta, in 1811.

It is with great regret we learn that owing to the heavy expense of printing and collating MS.S. the further publication of the work is abandoned.

distinguished object. It is the great storehouse whence succeeding poets have drawn their images and fables, and it has certainly had a very considerable influence on the literary productions of the country which gave it birth. Ferdoosee has the rare merit of having identified himself with the feelings and associations of his countrymen. His poems still continue to form the delight of the oriental world, and must endure as long as the language in which they are written. To such a man, in the strength of conscious genius it may without much imputation of vanity be permitted to exclaim, as he has done at the conclusion of his great undertaking, "Henceforward, I shall never die: and every one, who has knowledge and understanding, will, after my death, shower praises upon me." (12)

(12) So Ovid,

Jamque opus exegi, &c.

And Horace,

Exegi monumentum aere perennius, &c.

To me there is something fine in this proud consciousness of genius, relying on its own internal strength, not on the weak and mutable opinion of others,—in these confident anticipations of immortal fame, the richest reward of the poet. Who that has read the pathetic complaint of Camoens, at the end of the 5th. Canto of the Lusiad, does not rejoice to know, that amidst poverty and neglect, he was yet cheered with the hope that justice would one day be done to his injured merit.

THE writer of this sketch, is not conscious of having estimated too highly the genius of his Author; yet he is fully sensible of the task which remains to him of selecting some specimens of his works. Independently of the almost total impossibility of rendering faithfully, and, at the same time, with grace and spirit, the beauties of an original composition, our associations with words are so strong, and the terms of one language so seldom convey to the mind precisely the same ideas as the corresponding terms of another, that every one must have observed how often expressions, which present to us in the original pleasing images, translated literally, lose their charm, or even become ridiculous; and if this happens frequently in the European languages, much more so must it be the case in those of the East, the structure, idioms, and figures of which, differ so widely from our own. Though very doubtful of his power to do justice to his subject, he proceeds however to execute his intention, with rather the more

confidence, as, should the specimens, in their present form, not discover the merit which they appear to him to possess in their native dress, he still hopes that, as a literary curiosity, they may not prove altogether unworthy of attention.

Of a poem many times longer than the Iliad, and so irregular in its plan as the Shah-nameh, it would be impossible within the proper limits of a sketch, to give a full analysis, and the task of selection becomes difficult. It would have given the translator greater scope, to have chosen indifferently, from various parts of his works, examples of the several styles in which Ferdoosee has excelled; but he wished to give to his specimens the additional interest of connexion, and, at the same time, to afford an opportunity of judging of the manner in which the poet conducts his fable: he has thought it therefore better, on the whole, to take them from the same story, and he has selected for the purpose the Episode of Zaul and Roodabah, acknowledged to be one of the most beautiful portions of the Shah-nameh. Other parts of the poem might perhaps furnish us with passages of greater sublimity, but few or none are marked by more tenderness and feeling, or a deeper

knowledge of the human heart; qualities which, as they are rarely found in the compositions of Persia, render the genius of Ferdoosee the more admirable.

With respect to the translation of the specimens, he has only to observe that a prose one has been adopted from necessity, but would have been equally so from choice; as he thinks, with Sir W. Jones, that a prose translation only can give a faithful idea of the style and imagery of oriental productions. (13) He is not aware that he has taken any liberty with his original, except that of

(13) A poetical translation of the first part of the Shah-nameh was published some years ago by Mr. Champion, including the story from which the following specimens are taken. Of this translation I have never seen more than one copy, and it is, I believe, very rarely to be found. It may be consulted to obtain an idea of the nature of the work, but is too inelegant to be read with much pleasure, and too loose and paraphrastic to give a proper notion of the merits of the original. An elegant translation in verse of a beautiful episode of Ferdoosee by Mr. James Atkinson was published at Calcutta in 1814. This work is also I believe scarce in this country and deserves to be re-printed. It has however the same fault as Mr. Champion's, that of being too paraphrastic. Indeed a poetical translation seems hardly to be the proper medium for making known the peculiar genius, and giving a correct idea, of the poetical productions of nations, whose literature and language have been little studied; as the reader can never be sufficiently secure that the beauty he admires, may not be the addition of the translator. I have lately received from the continent a German translation of a part of the Shah-nameh, by Mr. Goerres, published at Berlin in 1820, in 2 vols. 8vo, but as this is to me, I am sorry to say, a sealed book, I cannot speak of the manner in which it is executed.

now and then retrenching a few lines, or an epithet which seemed to recur too frequently; and, in a few instances, of omitting or paraphrasing an image which appeared obscure, or too revolting to European taste. He is not so vain as to suppose that he has never mistaken the meaning of his author; those who best know the difficulties of Persian translation will the most readily excuse occasional errors of this nature: but he hopes that, on the whole, his copy, though not servilely literal, expresses sufficiently closely the sense and spirit of the original. He would have wished to have made a few observations on the nature and use of oriental figures, on the proper understanding of which, the beauty of Persian writings materially depends; but this is hardly the proper place to enter on an enquiry, which, treated fully, would extend this paper to an undue length. (14)

(14) As it may however throw light on some of the following passages, it may perhaps be well briefly to observe, that a great and essential difference between our writers and those of Persia, in the use of comparisons and similitudes, arises from this; that we require the thing compared to agree with the object of comparison in the major part, or at least in a considerable number, of its circumstances; whereas the Persian poet seeks only for a single point of resemblance.—For example: no comparison occurs more frequently in Persian poetry than that between a beautiful woman and the moon;—a comparison which, with our ideas, is apt to excite some ludicrous associations. Yet it is

To understand some of the allusions in the following specimens, it may be necessary to observe that Zaul is the son of Saum Nereemaun. one of the Generals of Manucheher, King of Persia. Having the misfortune to be born with white hair, he incurs the resentment of his father, who orders him to be exposed on the mountain of Elboorz, where he is nurtured by the Seemurgh, a fabulous bird which figures in the legends of Persia. Being afterwards restored to the favour of Saum, he is sent, in process of time, to govern the frontier town of Zaubul. The adjoining pro-

certain that no such associations enter into the mind of the Persian poet, who simply means to ascribe to the countenance of his mistress, the mild radiance and softened lustre so beautifully assigned to that planet by Pope in these exquisite verses:—

> So when the Sun's broad beams have tired the sight,
> All mild ascends the Moon's more sober light;
> Serene in virgin modesty she shines,
> While unobserved the glaring orb declines.

In this and all similar cases it would be a good rule for the translator from the Persian to introduce a word which marked the point of resemblance—"An eye *radiant* as the moon"—"A hero *strong* as an elephant, and *valiant* as a lion." It may just be observed in passing, that this oriental use of figures illustrates the application of many parables in the sacred writings,—those, for instance, of the "Unjust Steward" and "the Importunate Widow."

Those who wish to obtain more information on this subject will meet with some curious observations in Professor Lumsden's Persian Grammar, Vol. 2nd, p. 494.

vince of Caubul, though tributary to the Persian Empire, is governed by its own King, named Mihrab. The episode commences with a visit which Mihrab pays to Zaul. Zaul receives him with distinguished honour, and entertains him with a sumptuous banquet, of which having partaken, they separate with mutual admiration.

Then a chief, of those who surrounded him,
Said, O thou, the most illustrious warrior in the world!
This Mihraub has a daughter, veiled from all eyes,
Whose beauty is more resplendent than the sun;
From head to foot clear as ivory;
Her face radiant as the spring, and her form like the sabin-tree.
Upon her silver shoulders descend two musky ringlets,
Which, like a fetter, retain the captive:
Her lips are like the fruit of the pomegranate, and her cheeks like its flower;
Her eyes resemble the narcissus in the garden;
Her eye lashes are blacker than the plumage of the raven;
Her eye brows arched like a fringed bow:
Would you behold the radiance of the moon,—look upon her face!

Would you inhale delightful odours,—she is
all fragrance!
Her musky tresses are like chain-armour for
the neck,
Plaited together, knot upon knot:
Her fingers resemble silver reeds,
Upon which are stained a hundred characters.
She is altogether a paradise of sweets,
Decked with every thing that can rejoice the
beholder.

Zaul, on hearing this description immediately becomes enamoured of the fair unknown.

When Zaul heard these words,
He was moved with love to the beautiful
damsel;
And his heart became so inflamed with passion,
That understanding and rest departed from
him:
The night came, but he sat buried in thought;
He remained concealed, and a prey to sorrow.

On the following morning, Mihraub again visits the tent of Zaul, and endeavours to persuade him to return with him to his palace. This Zaul refuses, from the fear of offending the King, Mihraub being a descendant of

the usurper Zohak, and professing a religion accounted by the Persians idolatrous. On his return, Mihraub sees in a balcony his daughter Roodabah, and his queen Seendocht, who stops him to make some enquiries, concerning the hero.—Mihraub replies:

O beautiful silver-bosomed cypress!
The world will never behold the warrior
Who will surpass the illustrious Zaul;
In the painted palace, men will never behold
The image of so perfect a hero.
He has the heart of a lion, the vigour of an elephant,
And the strength of his arm is as the sweep of the Nile.
On his throne, he scatters gold before him;
In the battle, the heads of his enemies.
His cheeks are ruddy like the flower of the arghavan;
Youthful, sportive, and favoured by fortune;
And, though his hair is white as if with age,
Yet, in his rage, he would tear to pieces the water-serpent.
He springs to the conflict with the fury of the crocodile;
In the saddle he is a sharp fang'd dragon,
Staining the earth with blood,
As he wields his bright scimitar.

His white hair is his only defect;
In vain would the detractor seek any other fault:
Nay even the whiteness of his hair becomes him;
You would say,—He is born to win all hearts.

In consequence of this eulogium, Roodabah conceives a passion for the hero.

When Roodabah heard these words,
Her cheeks crimsoned like the flower of the pomegranate;
Her heart became inflamed with the love of Zaul;
She declined her food, and became a stranger to repose.

After some time she summons resolution to declare her passion to her attendants, and ask their counsel. The avowal of her affection, the astonishment and expostulation of the slaves, and the reply of Roodabah, are highly natural, spirited and poetical.

Then she said to her faithful slaves,
I will discover, what I have hitherto conceal'd;
You are the depositaries of my secrets,
My servants, and the partners of my griefs:

May good fortune ever accompany your steps!
Now therefore be informed,
That I am agitated with love, as the raging ocean,
Whose billows are heav'd to the sky.
My heart is filled with the love of Zaul;
In my sleep, my thoughts still dwell upon him:
He occupies my whole soul;
Night and day his image is ever present to me.
No one but you knows my secret,
You,—my affectionate and faithful servants!
What remedy do you now propose?
What is your counsel? what promise do you give me?
Some remedy you must devise,
To free my soul from this disquietude.

Astonishment seized the slaves,
That dishonour should invade the daughter of Kings;
In the anxiety of their hearts, they started from their seats,
And all exclaimed with one voice:
O crown of the princesses of the earth!
Pre-eminent even among the illustrious!
Whose praise is spread from India to China,
Distinguished in the Heram like a precious gem;

Whose stature surpasses the cypress in the garden;
Whose cheek rivals the lustre of the Pleiades;
The fame of whose beauty is spread from Canouge,
Even among the kingdoms of the west!
Have you no remains of modesty?
Have you lost all respect for your father,
That, whom a parent cast from his heart,
Him you will receive into your bosom?
A man who was nursed by a bird in the mountains!
A man who was for a sign among the people!
You,—who have filled the world with admiration!
Whose portrait hangs in every palace;
And whose beauty and understanding are such,
That they might draw down an Angel from the skies!

When Roodabah heard these words,
Her heart was inflamed like fire before the wind;
She uttered an angry exclamation,
But she cast down her eyes, and her cheeks were covered with blushes.
Then she said: Ignoble slaves!
It became not me to ask your advice:
The eye that is dazzled by the twinkling star,

How should it gaze on the splendid moon?
He will not regard the rose who is fond of
contemptible clay,
Tho' the rose is by nature more estimable
than clay.
I desire not the Cæsar, nor the Emperor of
China,
Nor any one of the monarchs of Iran;
The son of Saum, Zaal alone delights me,
Endowed with might and the strength of a
lion. (15)
Call him old or young,
He is my life and soul:
No one but he shall reign in my heart;
Speak not to me of ought but him:
Him my heart has chosen unseen,
Yes! has chosen him only from description!
My love is for him, not for face or figure;
And I have sought his love in the way of
honour.

This reply overcomes the reluctance of the slaves: they accede to her request, and one of them promises to bring about an interview.

(15) Should, at my feet the world's great master fall,
Himself, his throne, his world, I'd scorn them all;
Not Cæsar's Empress would I deign to prove!
No! make me mistress to the man I love.
Eloisa to Abelard.

The vermil lip of Roodabah turned to a smile;
She regarded the slave with a look full of pleasure:
If, said she, thou wilt bring this thing to pass,
Thou shalt cultivate a tall and fruitful tree,
Which every day shall produce rubies,
And pour its fruit into thy lap.

The slaves depart to execute their commission. They approach near enough to the camp, to attract the attention of Zaul, and employ themselves busily in gathering roses. Curious to know who they are, he sends his quiver-bearer to bring back an arrow which he shoots in that direction. The slaves enquire who the hero is, who draws the bow with such strength and skill. The boy disdainfully asks them how they can be ignorant that it is the renowned Zaul, the most perfect warrior whom the world had ever beheld. Piqued at his tone they begin to vaunt the superior excellencies of Roodabah, and break out into an exaggerated description of her charms. Zaul repairs to the slaves, declares his passion, and requests them to procure him an interview with the object of his affection, which they promise, if possible, to obtain. This little incident is, on the whole, well imagined: it is Zaul who is made to desire

the meeting, and the honour of Roodabah is not compromised.

The slaves return to their mistress to render an account of their embassy, and express the highest admiration of the personal graces of the hero. The irony of her reply, in allusion to their former depreciation of him, is animated and natural.

Then the Princess exclaim'd to the slaves,
Have ye then changed your opinion and counsel!
Is this the Zaul nursed by the seemurgh?
This the old man grey and withered?
Now his cheeks are like the arghavan;
He is lofty of stature and graceful in form!
You have exalted my charms before him;
You have spoken, and demanded a price.
She spoke, and her lips were suffused with smiles,
But her cheeks crimsoned like the flower of the pomegranate.

The interview of the lovers takes place in a private pavilion, belonging to the Princess: the description of their meeting is marked by some touches of great delicacy and beauty.

As soon as the hero appeared in her presence,
She exclaimed,—Welcome, generous and happy youth!
The blessing of God be upon thee!
The happiness of the favoured of Heaven be thy portion!
May thy heart ever rejoice in the kindness of fortune!
Thy soul be ever free from pain and sorrow!
The dark night is enlightened from the beaming of thy countenance;
The world is perfumed from the fragrance of thy presence.
Thou hast wandered hither from thy palace on foot;
Thou hast encountered trouble and fatigue to behold me!

The warrior heard the voice,—
He looked, and beheld a countenance brilliant as the sun,
Enlightening the pavilion like a precious gem,
And the earth like a blazing ruby.
Then he said: O lovely maid!
Thy good wishes are the blessing of Heaven.
How many nights, under cold Arcturus,
Have I passed in supplication before the pure God,

Beseeching the Ruler of the world,
That he would give me to behold thy face:
Now am I happy in hearing thy voice,
In listening to thy mild and gracious accents.
But tell me now how I may behold thee face to face,
For what converse can we hold, I on the ground and thou on the terrace?

The maiden heard the words of the hero;
She quickly unloosed her auburn hair,
Plaited together knot upon knot;
And she stooped and dropped her tresses from the wall,
And cried: Take now these tresses, they belong to thee,
And I have cherished them that they might prove useful to my beloved. (16)

And Zaul looked upon the maiden,
And he was astonished at her loveliness;
He covered the musky tresses with kisses,
And his bride heard the sound from above.
Then he exclaimed: far from me be such injustice,
May the bright sun never shine on such a day;

(16) This is the passage to which Moore alludes in his Lalla Rookh. 8vo. ed. page 183.

It were to lay my hand on my own life,
It were to plunge the arrow into this wounded bosom.
Then he took out his noose, and made a running knot,
And threw it, and caught it on the battlement;
And held his breath, and, at one bound,
Sprang from the ground, and reached the summit.

As soon as the hero stood upon the terrace,
The lovely damsel came and greeted him,
And took the hand of the hero in her own,
And they were as those who are inebriated with wine.
Then he descended from the terrace,
His hand in the hand of the tall maiden;
And they entered the splendid pavilion
Which blazed with light like the bowers of Paradise:
And Zaul gazed with astonishment
On her tall form and enchanting beauties.
Then he kissed and embraced her,
And said, O lovely maiden!
When Manucheher shall hear of this,
I fear that he will not approve of our affection:
I fear also the anger of Saum,

And that he will lift up his hand against me.
Yet, though life is dear to all men,
Life I will despise, and am ready to resign:
I swear by the just God,
That never will I break my faith with thee;
I will go and bow before him,
And supplicate him in sincerity of soul,
To cleanse the heart of the King of the earth
From indignation, hatred, and malice:
Perhaps the Creator of the world will listen
to my prayer,
And thou may'st yet become my wife.

Then said Roodabah,
I also swear to thee the same faith,
And he who created the world be my witness,
That no one but the illustrious Zaul
Shall ever be lord of my affection.

Thus love sped away the time,
Prudence was far removed, and passion predominated,
Till the grey dawn began to appear,
And the drum to be heard from the royal tent.
Then Zaul bade adieu to the Princess;
His heart became dark and his bosom on fire,
And the eyes of both were filled with tears,
And they lifted up their voices against the
sun,

And said, O light of the universe! why come
so quick?
Could'st thou not wait one little moment?

Then Zaul fixed his noose to the battlement,
And descended from the pavilion,
As the sun rose from behind the mountains,
And the bands of warriors issued from their
tents.

On his return to the camp, Zaul convenes the sages, and demands their advice. They counsel him to write to his Father, and be guided by him. Zaul accordingly writes to Saum. In his letter he recals to the mind of his Father, in an affecting manner, the sufferings he had endured, when abandoned by his parents in the mountains; conjures him to consent to his union with Roodabah, and reminds him of a promise he had made when reclaiming him from the Seemurgh, that in all the future circumstances of his life, he would endeavour to efface the remembrance of his cruelty, by a cheerful compliance with his wishes.—Saum is much embarrassed by this letter: on the one hand, he fears the reproaches of his son; on the other, the anger of the King. At length he convenes the sages, and bids them declare what will be

the result of the union of Zaul with a Princess of the line of Zohak. After the intense study of many days, they prophecy the birth of the celebrated Rustam.

The sages approached and said,—
O warrior of the Golden Belt!
Joy will be to thee, from the union of Zaul
with the daughter of Mihraub;
For they are two illustrious equals,
And from them shall be born a hero, in
strength like the elephant,
Who shall gird his loins in manliness.
He shall bear dominion on his sword,
And shall exalt the throne of the King above
the clouds;
He shall cut off the malevolent from the land,
Nor leave a den of violence on the face of
the earth;
He shall leave neither Deeve nor inhabitant
of Mazinderan,
But shall sweep the earth with his mighty mace:
From him Turan shall suffer many woes,
And Iran shall enjoy all happiness.
He shall cause the afflicted to repose in peace,
And shall close the door of sorrow and the
path of calamity:
The hope of the inhabitant of Iran shall be in
him,

And in him the confidence and joy of the hero.
The courser of the warrior shall fly before
him in the battle,
And he shall bruise the faces of the tigers of
war;
And the heroes, bold as lions, and furious as
elephants,
Shall vanish from before his weighty club;
And in his time joy shall be to the kingdom,
And his name shall ever be coupled with
renown. (17)

On hearing this prophecy of the future greatness of his grandson, Saum becomes reconciled to the marriage, but writes to Zaul to delay the celebration of it until he has been to the court of Manucheher, and obtained the consent of the king. Zaul, transported with joy, immediately sends the letter to Roodabah. The messenger, on her return, is espied by Seendocht, and the secret correspondence of the lovers is discovered. The interview between the mother and daughter is thus described by the poet.

Then she entered into the pavilion,
Full of care and sorrow and anxiety;

(17) This and all the descriptions of the character of Rustam in the Shah-nameh put the reader strongly in mind of the Grecian Hercules.

She closed the door of the apartment,
And was as one that is insane from the tumult of her thoughts.
She commanded that her daughter should appear before her;
And she struck her hand upon her own face,
And the tears flowed from her radiant eyes,
Till her cheeks became inflamed like the crimson rose.
Then she said,—O illustrious maid!
Why hast thou approached so near the precipice!
What is there desirable in this world,
Which I have not been careful to point out to thee?
Why then art thou so unjust to me?
Tell all thy secrets to thy mother:
Who is this maid, and wherefore is she come;
And for whom are intended the ring and turban?

Roodabah fixed her eyes on the ground;
She remained abashed at the sight of her mother:
The tear of affection gushed from her eye,
And her cheeks were crimsoned with the falling drops.
Then she said,—O prudent parent!
Love chaces away the repose of my soul:

Would that I had never been born!
That neither good nor evil had been spoken
of me!
The warrior Zaul came to our plains,
And my bosom became so inflamed with his
love,
That the world is become contracted in my
sight:
Night and day I weep continually.
I desire not to exist except in his presence;
The world is of less value to me than a single
hair of his head.
As soon as he had seen and conversed with me,
Hand in hand we plighted our faith;
But except seeing and conversing,
Nothing else passed between us.
An ambassador went to the mighty Saum;
At first the chief was grieved and distressed,
But at last gave his consent:
I also saw the letter to Zaul,
He sent it me by the hand of the slave whom
thou hast punished,
And these presents were an answer to the
message.

Seendocht was astonished at her words,
And in her heart approved her daughter's
choice.
She said,—Here indeed is nothing mean;

For there is no one among the illustrious like
the hero Zaul:
He is mighty, and the son of the most re-
nowned warrior in the world;
He is wise and prudent, and of a noble soul.
But I fear that the king of the earth will be
enraged,
And will raise the dust of Caubul to the sun;
For never will he suffer one of our seed,
To place his foot in the stirrup.

King Mihraub came joyfully from the hall of
audience,
For Zaul had spoken much in his praise.
He beheld, reclined, the illustrious Seendocht,
Her face pale and her heart agitated;
And he said,—What ailest thou?
And why are the roses of thy cheeks faded?

Then Seendocht answered and said,—
My heart is filled with anxious cares.
This collection of presents and treasure;
These Arabian horses superbly arrayed;
This palace and these beautiful gardens,
And this company of faithful friends;
This band of slaves attached to their master;
This crown and imperial throne,
And all our reputation for wisdom and pru-
dence;
All now is wasting away:

Unwillingly we must resign them to the enemy,
And tell our sorrows to the winds.
One narrow chest will now suffice for us:
The tree, which should have been the antidote, is become the poison.
I planted, cultivated, watered it with care;
I hung a crown and jewels on its branches, (18)
But when it had raised itself to the sun, and expanded its shade,
It fell to the ground and destroyed my hopes.
Such is the end of all our labours,
Nor know I where we should seek our rest.

Then said Mihraub to Seendocht,—
Is this then any new thing?
This transitory world is but an inn;
One is neglected, and another enjoys every comfort;
One comes, and another departs,
And whom hast thou seen that fortune does not persecute?
By anxiety of heart thou wilt not drive sorrow to the door:
There is no contending with the just God.

(18) Those who are interested in such enquiries will meet with a curious dissertation on the high respect paid to certain trees in the East, to which an allusion is here made, in the appendix to the 1st vol. of Sir W. Ouseley's Travels in Persia, p. 359—401.

Then said Seendocht,—know that the son of Saum
In secret has insnared the affections of Roodabah;
He has seduced her noble soul from the right way,
And now some remedy must be found for the disease.
I have given her much counsel, but it availeth nothing:
I see her heart broken, her face pale,
Her soul still full of sorrow and anxiety,
Her lips still utter the bitter sigh.

When Mihraub heard these words he leaped on his feet,
And struck his hand on the hilt of his sword;
His body trembled, his face became livid,
His soul full of wrath, and his lips quivered:
This moment, he exclaimed, the blood of Roodabah
Shall flow in a river on the ground.

When Seendocht saw this, she sprang from her seat,
She seized the belt of the hero with both her hands,
And exclaimed,—Hear one word;
Give ear one moment to thy inferior;

Then do as thou shalt see fit,
As thy heart and guiding wisdom shall dictate.

Mihraub writhed, and flung her from him;
He uttered a cry like a furious elephant,
And exclaimed:—When a daughter was born,
I ought to have caused her immediately to be destroyed:
I killed her not; I walked not in the way of my fathers;
And this now is the return which she has made me.
Should the hero Saum join with Manucheher,
And prove superior to me in war,
The smoke will go up from Caubul to the sun;
Neither house will remain, nor stone unturned.

Then Seendocht said,—O warrior!
Speak not thus wildly,
For Saum is already informed of this affair:
Dismiss from thy mind all fear and anxiety.

Mihraub answered,—O radiant beauty!
Speak not to me deceitfully:
My heart would be free from pain,
Wert thou secure from injury:
Than Zaul there is not a man more estimable,
Either among the nobles or the people;

Who is there who would not desire the alliance of Saum,
From Awaz even to Kandahar?

Then Seendocht said,—O illustrious chief!
Why should I speak the words of deceit?
Thy dangers are plainly my dangers,
And thy sorrowing heart is bound up in mine.
For this didst thou see me thoughtful and anxious,
Plunged in sorrow, and joy banished from my soul.
Yet should this be brought to pass, it were not so wonderful,
That thou should'st regard it as impossible:
Fereedoon approved the daughters of Arabia;
The conqueror of the world saw, and gave his consent.

Mihraub gave ear to the words of Seendocht,
But his heart still boiled with passion;
He commanded the Princess to rise,
And bring Roodabah to his presence,

But Seendocht was afraid of the lion-hearted man,
Lest he should strike Roodabah to the dust;
And that heavenly flower, the pride of the garden,

Should be swept away from the land of Caubul:
Give me first, she said, a promise,
That thou will return her safe to my arms;
Take a solemn oath,
That thou wilt wash out the thoughts of vengeance from thy heart.

The warrior gave his word,
That Roodabah should suffer no harm:
The King of the universe, he said,
For so foul a deed would withdraw his protection from us.

When Seendocht heard this she stretched out her neck,
And bowed her face to the ground.
Then she came to her daughter with a smile on her lips,
And a face like the dawn rising upon the night;
She told her the good news, and said,—
The tiger has released the antelope from his gripe:
The hero Mihraub has sworn by the righteous God,
That he will not injure a hair of thy head:
Now then put on thy most splendid dress,
Go to thy father, and lament thy fault.

But why in splendid dress, said Roodabah?
All my hopes are centred in one,
My heart is fixed on the son of Saum,
And why attempt to conceal what is well known.

She approached her father like the rising sun,
Immersed in a blaze of gold and jewels,
Resembling some beautiful creature of paradise,
Or the bright sun in the smiling spring.

When her father beheld her, he stood fixed in astonishment,
And invoked in his heart the Creator of the world:
O void of wisdom! he exclaimed,
Should a Peri unite with Aherman?
If a serpent-charmer should appear from the desert of Kohtan,
Would it not be lawful to slay him with the arrow?

When Roodabah heard this answer, her heart burned within her,
And her face was crimsoned with shame before her father;
Her eyelids fell over her dark tearful eyes,
She remained motionless and drew not her breath.

Mihraub raged like a furious tiger,
His soul full of passion and revenge:
Roodabah returned heart broken to the house,
And mother and daughter sought refuge with God.

Meanwhile Saum arrives at the court of Manucheher. A report of the intended marriage of Zaul has already reached the ears of the King, who, having consulted his counsellors, is determined to forbid it. He receives Saum however with great distinction, and commands him to relate the history of his wars in Mazinderan. In answer to the enquiries of the King respecting his battle with the Deeves, or inhabitants of that country, Saum thus replies.

O King, live for ever!
Far from thy soul be the counsels of the wicked:
I came to that city of Deeves;
What Deeves,—but warlike lions?
They are swifter than the horses of Arabia;
More valiant than the heroes of Persia;
Their army, which they call Sagsar,
You would say were tigers of war.

When they heard the news of my arrival,

They became distracted with fear;
They raised a tremendous shout,
And abandoned their city,
And collected an army so immense,
That the dust thereof obscured the light of day.
They advanced to seek the battle,
Like men insane, or prowling wild beasts;
The earth trembled, and the sky was involved in darkness,
As they filled the hills and the vallies.
Fear fell on my army,
And my mind was filled with anxiety;
With a hundred blows of my mace,
I compelled them to pass the boundary:
Then I came, and bruised the faces,
And clove the heads of the enemy.

A grandson of the mighty Salm
Came like a wolf to the battle;
The name of the illustrious warrior was Caucavee,
He was beautiful of countenance, and tall as the cypress;
By his mother he was of the race of Zohak:
Heroes were as dust before him.
His army was as a host of ants or locusts,
The multitude thereof covered the hills, the plains, and the vallies.

When the dust arose from the approaching
army,
The cheeks of our warriors turned pale:
But I raised my mace, and urged them for-
ward;
I shouted so loud from the back of my courser
That the earth revolved as a wheel before them.
Courage resumed its seat in the breast of my
soldiers,
And with one consent they rushed to the battle.

When Caucavee heard my voice,
And saw the wounds of my ponderous mace,
He came to meet me with his long noose,
Rushing to the combat like a furious elephant.
He wished to entangle me in the knot,
But I leaped out of the way of danger,
And, seizing my Caianian bow,
I selected my choicest arrows,—
Made them fly like eagles,
And poured them upon him like flame.
I thought to have pierced his brain,
And nailed his helmet to his head,
But he rushed from the cloud of dust like a
mad elephant,
His Indian sword in his hand,
And approached me, O King, with so much
fury,
That even the mountains trembled.

With slow caution I awaited his attack,
Until he came within arm's length;
Then, as the warrior threw himself upon me,
I darted out my arms from my war horse,
And, trusting in the fortune of my victorious King,
And invoking the aid of the Creator of the universe,
I grasped the belt of the hero,
With the strength of a lion raised him from his saddle,
Flung him to the ground like a furious elephant,
And plunged my Indian sword in his heart.

When their leader was thus laid low,
The enemy turned their face from the field of battle;
And flying in crowds on every side
Filled the plains and mountains, the hills and vallies.
Horse and foot we numbered thirty thousand
Who fell upon the field of battle;
Twelve thousand valiant men
Became captives of war:
What, O King, can the power of the malevolent,
Against thy fortune, and the supporters of thy throne.

When Saum has finished this narrative, Manucheher immediately commands him to march against Mihraub, lay waste his country, and extirpate his family. Saum, without daring to expostulate, promises to obey his orders. On his way he is met by Zaul, who earnestly implores him to suspend his purpose, and to permit him to go himself, and urge his suit before the King. Saum complies with the wishes of his son, and seconds his request in a letter to Manucheher, in which he takes occasion to mention several services which he had performed, and in particular that of having slain an immense Dragon, which had for a long time infested and desolated the country.

Had I not been in the land,
Even the mighty would have perished,
When the huge Dragon
Came up and desolated the earth:
His height was as the distance from city to city,
His breadth as that from mountain to mountain.
The people were filled with terror,
From the dread of him they rested neither day nor night.

I looked, and there was not a bird in the air,
Nor a beast of prey on the face of the earth:
His venom was fatal even to the Kergesh;
The grass withered beneath his poison;
He drew the fierce crocodile from its waters,
And the soaring eagle from its clouds;
And the earth was cleared from man and beast,
And all abandoned their habitations to him.

And when I saw that there was no one in the land,
Who was strong enough to contend with him,
Relying on the power of the pure God,
I cast from my heart all fear and anxiety:
I girded my loins in the name of the Most-High,
And vaulted on my fleet and valiant charger;
And, seizing my cow-graved mace in my grasp,
With the bow in my hand and the shield on my shoulder,
I went forth like a fierce crocodile,
To combat with the terrible dragon:
And every one who heard my purpose
Exclaimed,—farewell, as I passed.
I came, I beheld him like a lofty mountain,
Dragging his mane as a net upon the ground;
His tongue resembled the black tree, (19)

(19) There is a little obscurity here: the passage perhaps refers to the Upas or poison tree of Java.

As, with open jaws, he glided on his way;
His eyes were two fountains of blood;
He saw me, roared and sprang upon me with fury.
It appeared to me, O King;
As though flames were issuing from his mouth;
But I shouted with the voice of a lion,
And approached him as became a valiant man;
I seized a steel-pointed shaft,
And shot it hastily through the air,
And so directed the obedient arrow
That it nailed his tongue to his palate.
Again I struck him in the mouth,
And he writhed from the anguish of the wound.
A third time I pierced his jaw,
And the boiling blood rushed from his vitals:
Then, trusting in the power of the Ruler of the universe,
I dashed the huge monster to the ground,
Smiting him on the head with the cow-graved mace,
As though the skies had rained down a mountain upon him.
I clove his head with the rage of a furious elephant,
And a stream of poison rushed from his body.
The rivers were filled with blood and venom,
But the land again became a place of rest and gladness,

And the mountains were covered with men
and women,
Who called down blessings upon me. (20)

The rest of the story must be told in few words, for this paper has already extended to too great a length, and specimens have been adduced sufficient to give some idea of the character of Ferdoosee's poetry. Zaul arrives at the court of Manucheher. The King is happily pleased with his appearance, and the proofs which he gives of his wisdom and courage; but his fears still make him hesitate to grant his request, and it is not till he has again consulted the astrologers, who return a favourable answer, that he can be induced to sanction it with his approbation. Zaul returns to Caubul to communicate the glad tidings to Roodabah. The nuptials are celebrated with great pomp; and the offspring of the marriage is the celebrated Rustam, who plays a distinguished part among the heroes of Persia in a subsequent part of the Shah-nameh.

(20) The reader may compare this passage with a similar one in Ovid, *Metam. L.* III. v. 31 *et seq.*

Such is the sketch which the Author of this paper proposed to give of the life and genius of Ferdoosee. He has ventured upon a subject, of no general importance, but he hopes, not totally unprofitable or uninteresting. Should it have been otherwise, he has only to beg the indulgence of the Society for occupying their valuable time, and supposing that these trifles, the amusement of some leisure moments, might not be incapable of yielding them an hour's entertainment.

ON OIL,

AND THE

GASES OBTAINED FROM IT

BY HEAT.

BY JOHN DALTON, F. R. S. &c.

(Read October 6th, 1820.)

HAVING lately had occasion to make some experiments on the effects produced by heating oil, particularly that species of fixed oil, derived from the animal kingdom, I have thought it would not be uninteresting to the members of this society, to have the results laid before them: especially as the gas produced from the decomposition of this kind of oil is likely to be introduced in a greater or less degree, as a substitute for that from coal for the purpose of illumination.

When whale oil is heated over a fire in an open vessel, it gradually acquires temperature, like any other liquid, till it arrives

at about 400° of Fahrenheit. After this it begins to exhale a vapour, which is chiefly aqueous; and this continues for some time. When the temperature arrives at the confines of 600°, symptoms of ebullition begin to appear, by a number of small bubbles of air and vapour emerging from the surface of the oil. The heat being continued, the temperature gradually increases from 600 to 650° or upwards, when the whole surface has a very gentle curl or agitation, which continues without much change as long as the temperature is kept between the limits of 650° to perhaps 700°. The higher limit is not very easily ascertained, by reason of the mercurial thermometer ceasing to be a measure of temperature at that extreme. There is a striking contrast between the violent agitation of water and the gentle agitation of oil, in a state of ebullition. When a quantity of whale oil, is subjected to distillation in a glass retort, it may be gradually heated to 500° or upwards, at which time a little water and oil will have distilled over, amounting to $\frac{1}{50}$ or $\frac{1}{50}$ of the whole. This being withdrawn and another receiver placed, a portion of oil will be distilled, mixed with a little water, when the temperature reaches 600°. Ebullition having commenced, the distillation quickens

a little, but it is a very slow operation. A pint of oil was about $\frac{1}{7}$ part distilled in two or three hours' constant ebullition. The boiling at last was as steady and tranquil as at first; and the receiver and retort were free from cloudiness.

A quantity of acid fumes were discharged and filled the small room where the above process was carried on, so as to affect the throat and to feel very suffocating. Probably these fumes were the sebacic acid mixed with carbonic acid; they did not appear to be at all combustible.

Whale oil is considerably altered by distillation, both in specific gravity and in its other properties. I did not notice the specific gravity of the above before distillation; but this species of oil is usually ,92 nearly. After distillation the residuum had the specific gravity ,94; whereas the distilled part had the specific gravity ,85, the first produce or watery part being thrown away. The residuary oil is black and less fluid than at first; the distilled part is more fluid than at first.

I found the specific gravity of old whale oil that had been heated continually for 35 days to 360°, but had never been boiled, to be ,960. It nearly resembled the residuary oil in the above-mentioned distillation.

If either new whale oil or old oil that has been often heated to 400° or upwards, be gradually heated to 500 or 520°, and at any period a lighted match be plunged into it, the match will be instantly extinguished and no combustion ensue.

A portion of the distilled oil mentioned above was heated in an open cup to 250° and then to 300°. A lighted match was presented to the surface and a slight explosion ensued, occasioned no doubt by the oil vapour; but when the match was plunged into the oil it was extinguished. When oil is repeatedly distilled it becomes more and more inflammable and evaporates at a lower temperature.

Old oil that had long been exposed to a heat of 400°, was taken and put into a digester, to the amount of a gallon or more. The digester was furnished with a small pipe to the lid: the oil was heated to 450° without any remarkable effect. From thence it was gradually raised to 568°. At 526° on applying a match to the pipe, a slight blue flame appeared which soon was extinguished. From that temperature upwards, desultory puffs of inflammable vapour proceeded from the pipe, occasioned by the dropping of aqueous and oily matter from the lid on the surface of the heated fluid; but no permanent gas was produced.

A large boiler containing from 50 to 100 gallons of whale oil, which had been kept at the temperature of 400° for 35 days successively was next a subject of experiment. It was close, except a small pipe of an inch diameter and about 15 feet long elevated from the lid of the boiler. The oil which half filled the boiler being at the temperature of 400°, a candle was several times applied to the end of the pipe, but no appearance of inflammation was observed. A large plug was then taken out of the lid and a lighted match was applied to the orifice. No appearance of inflammation ensued. The match was then plunged into the interior of the boiler, under the surface of the lid, and was immediately extinguished. I had no opportunity of examining the state of the air within, but had reason to expect there was a mixture of carbonic acid and common air.

A glass retort containing about a pint of old oil that had been long heated, was kept at the temperature of 600° or upwards for an hour or more. The beak of the retort was made to terminate in a wooden box, nearly air-tight and containing common air, during the whole process. The box was about a half a cubic foot in capacity. At the end of the time a small opening was made in the

box, and a lighted taper was put in. No explosion or inflammation ensued. The air within was examined; the taper burned in it much the same as in common air. It had about 17 per cent. oxygen and a little carbonic acid. It had the suffocating smell of sebacic acid. Hence it is evident there was no inflammable gas or vapour in the box.

Gas from Oil by Heat.

The first time I procured gas from oil was in 1805. I find among my notes at that time that a quantity of gas was obtained by putting olive oil into a gun-barrel along with hydrate of lime and applying a red heat. By a few trials I concluded it to be a mixture of carburetted hydrogen, olefiant gas and hydrogen. Since that time I have not made any oil gas till the present. Dr. Henry had previously found that the gas from oil and from tallow contains $\frac{1}{7}$ of its bulk of olefiant gas, and that from wax $\frac{1}{4}$, the rest being hydrocarburet, as it was then called. (Nicholson's Journal 11—page 70, 1805.)

The gas from oil appears to be variable in its qualities; partly, I apprehend, from the different species and qualities of the oil, but chiefly from the variations in the mode of obtaining it, and the degrees of heat at which the decomposition is effected. We learn from Dr. Henry's experiments on coal gas (Philos. Trans. 1808,) that the best coal gas comes over in the early part of the distillation, and before the greatest heat is applied to the retorts. The same seems to obtain in the decomposition of oil; and it seems probable that the gas will be the best which is obtained with the most moderate heat, all other circumstances being the same. From the experiments already detailed it is evident that the heat for decomposing oil must considerably exceed 700°, as it sometimes rises to that point or near it in the process of distillation, in which very little, if any gas is produced. A heat visibly red at least seems required for the decomposition of oil into a permanent elastic fluid.

The usual mode of decomposing oil is I believe, to let the oil descend by drops into an iron retort heated red, in which is a quantity of some substance having little or no chemical action upon oil, such as charcoal, pounded bricks, &c. The object of which

is merely to increase the heated surface, in order to accelerate the decomposition. In my experiments on a small scale I have put the whole quantity of oil into the retort at first, not amounting to more than $\frac{1}{4}$ or $\frac{1}{2}$ of an ounce, and without any of the materials above-mentioned. The retort being comparatively large and only one end of it heated red, I found no inconvenience from any sudden rush of the gas, nor from any quantity of oil that might escape decomposition.

I have made three experiments at different times on the decomposition of oil. The first, I think was on spermaceti oil, and the other two on common whale oil of the same parcel. The first gas was exceedingly good, being of better quality than any I have seen an account of; but I regret that the quantity was too small to admit its specific gravity to be taken. The second was comparatively good, and its specific gravity was nearly the same as that of common air. The third was somewhat inferior in quality, but more so in its specific gravity, it being only .7 of common air. I have little doubt but the first was heavier considerably than common air. All the three contained undetermined proportions of carbonic acid, but amounting to 10 or 20 per cent., which were taken out previously to their being weighed.

In addition to these three specimens I had a fourth which Dr. Henry was so good as to favour me with, obtained from whale oil. This was of the specific gravity .59.

On exploding the gas No. 1, with oxygen in Volta's eudiometer, I found that it required three times its bulk of oxygen gas, and produced rather more than twice its bulk of carbonic acid, and hence I concluded it must be olefiant gas nearly pure. For it has been shewn by several chemists that 100 measures of olefiant gas, when exploded as above, produce 200 of carbonic acid and require 300 of oxygen gas, or thereabouts. This led me to examine it by the test of oxymuriatic acid, when I was surprised to find that not quite one-half of the gas was immediately combinable with oxymuriatic acid, and the remainder appeared to be carburetted hydrogen chiefly, as well by the test of Volta's eudiometer as by its action on oxymuriatic acid in the direct solar light.

The first impression which this observation made on me, was that the gas from oil was one *sui generis* or of a peculiar kind not yet described, and that oxymuriatic acid effected a decomposition of it, combining with that portion of the ultimate element which corresponds to olefiant gas, and evolving the

the other portion corresponding to carburetted hydrogen. Succeeding experience however inclines me to believe that this last gas, as well as portions of hydrogen and carbonic oxide, constitute a part of the mixture of gases produced originally by the decomposition of oil; and that the portion which is acted upon by oxymuriatic acid is either a gas hitherto not described, or a mixture of olefiant gas and one or two other gases that have not yet been characterized.

I tried the gas, No. 1, in regard to absorbability by water; it appeared to agree nearly with olefiant gas in this respect, the absorption being much the same as would have resulted from a mixture of carburetted hydrogen and olefiant gas in the due proportions. Oxygen gas expelled the mixed gases unaltered, agreeably to the known rule in such cases, and no change was observed in the nature of the gases in treating them afterwards with oxygen in Volta's eudiometer, except that resulting from their difference in absorbability.

The gas No. 2, contained 16 per cent. of this new gas, which for the present I shall call superolefiant. The gas No. 3, contained 10 per cent.; and that No. 4, contained 20 per cent. of the same. After the superolefiant gas was taken out, the residues of the

different specimens were not alike: No. 1, was chiefly carburetted hydrogen; No. 2, contained carburetted hydrogen and carbonic oxide; No. 3, consisted chiefly of carburetted hydrogen; and No. 4, contained carburetted hydrogen, carbonic oxide and hydrogen; as will be obvious from the results of their analyses exhibited below. The analyses were effected in this way: One hundred measures of the washed gas were fired with the due proportion of oxygen, over mercury, and the acid and oxygen determined in the usual way: next 100 measures of the same gas were treated with oxymuriatic acid to take out the superolefiant gas; the excess of acid being washed out, the residue was fired and the carbonic acid and oxygen determined; these were then subtracted from the results of acid and oxygen for 100 gas, and the remainders were put down as due to the combustion of the superolefiant gas.

No. 1. 100 Measures, gave 185 carb. acid—took 310 oxygen.

Consisted of
- 46 Superolefiant — 141 ——— — 230 ———
- 50 Residue comb.— 44 ——— — 90 ———
- 4 Azote

No. 2. 100 Measures, gave 119 carb. acid—took 190 oxygen.

Consisted of
- 16 Superolefiant — 60 ——— — 109 ———
- 56 Resid comb. — 59 ——— — 81 ———
- 3 oxy.
- 25 azote

No. 3. 100 Measures, gave 97 carb. acid—took 191 oxygen.

Consisted of { 10 Superolefiant —— 38 ——— —— 70 ——
79 Resid. comb. —— 59 ——— —— 111 ——
1 oxygen
10 azote

No. 4. 100 Measures, gave 97 carb. acid—took 172 oxygen.

Consisted of { 20 Superolefiant —— 56 ——— —— 97 ——
71 Resid. comb. —— 41 ——— —— 75 ——
9 Azote

On comparing these results, there is found a very considerable difference in them with regard to the proportions of carbonic acid and oxygen due to the superolefiant gas. The carbonic acid produced is from 3 to 4 times the volume of the gas, and the oxygen expended is from 5 to 7 times the volume. These differences are partly due no doubt to inaccuracies in such complex experiments; but I am persuaded they cannot all be ascribed to that cause. If we were to *average* the results, the proportions would be nearly 100 measures, for 300 carbonic acid, and for 500 oxygen. In order to form a gas of this character it would only be required to combine an atom of olefiant gas with 1 of carburetted hydrogen, and to condense them both into the space of 1 atom of olefiant gas.

Another supposition might be made, of two atoms of olefiant gas united and comprised in the space of one. In this case, 100 measures would give 400 carbonic acid and require 600

oxygen. This supposition would fall within the compass of some of the results.

I think it is perhaps as probable as the contrary that both these new compounds exist in oil-gas; but as no reason seems to exist why the olefiant gas of the Dutch chemists, or that from alcohol, should not be found in the decomposition of oil, it would seem the most simple way of accounting for the phenomena to suppose that part of the gas from oil which we have called superolefiant to be a mixture of the ordinary olefiant gas, and a new one of double its power. It is not possible however to reconcile the results above with this supposition. They require the *two* new gases or combinations of gases above suggested, and in this case we can do without the aid of any olefiant gas properly so called. At present the subject must remain in uncertainty.

In prosecuting this enquiry it struck me that the olefiant gas mixed with coal gas, might propably be of this new kind. From Dr. Henry I received a specimen of coal gas of the first quality, which on examination gave the results below:—

100 Measures, gave 128 carb. acid—took 233 oxygen.

Consisted of	16 Superolefiant	46	——	——	71	——
	82 Resid. comb.	82	——	——	162	——
	2 Azote					

Now though this result of the superolefiant gas from coal does not accord with any of the 4 preceding results from oil, it comes much nearer them than it does to that from olefiant gas. So that it is probable the destructive distillation of coal gives the same superolefiant gas as that of oil; and perhaps the alcoholic olefiant gas makes no part of the mixtures in either case.

May,—1823.

Some time having elapsed since the above paper was read, some additional information on the subject may be expected. An excellent memoir by Dr. Henry, was published in the Philos. Trans. for 1821, (see also An. of Philos. *new series* vol. 2) on the æriform compounds of charcoal and hydrogen, in which is given a copious detail of experiments on oil-gas. These results will be read with great interest, more especially by those concerned in gas establishments. It may be useful to extract from said memoir the first

Table giving an account of the results of analyses of four different specimens of oil-gas. From these it appears that as great differences may be found in the qualities of oil-gas as of coal-gas; though all other circumstances being the same, oil-gas is better, volume for volume, than coal-gas, by about 10 per cent.

TABLE: *Gas obtained from Whale Oil.*

Entire Gas.*					Residue left by chlorine.		
No. of Expts.	Sp. Gr.	100 Vols. lose by chlorine.	100 Volumes. take oxyg.	100 Volumes. give carb. acid	Sp. Gr.	take oxyg.	give carb. acid.
1	,464	6	116	61	,4107	94	46
2	,590	19	178	100	,4400	108	58
3	,758	22. 5	220	130	,6160	145	85
4	.906	38	260	158	,6060	152	91

I have occasionally repeated my experiments on oil-gas ever since the discovery of the superolefiant gas in Sept. 1820. Recently (Sept. 1822) I examined a specimen of oil-gas furnished by my friend Thomas Hoyle, such as he commonly uses for the purpose of

* That is the gas after having its carbonic acid extracted carefully by caustic potash.

illumination. The entire gas including the carbonic acid, which was about 7 per cent., was found by weighing to be of the specific gravity ,875. After extracting the carbonic acid by lime water (7), the rest (93) took 210 oxygen and gave 128 carbonic acid by Volta's eudiometer; and there was a remainder of 10 incombustible, having all the marks of azotic gas. Also 100 measures of the entire gas reduced to 93 by lime-water, being treated with 40 or 50 measures of oxymuriatic acid gas, lost instantly 30 measures, as was found by washing out the excess of oxymuriatic acid; the remaining 63 were not sensibly affected by a second portion of oxymuriatic acid for at least 5 minutes in full day-light. This residue 63, being fired with oxygen, took 89 measures, and yielded 46 of carbonic acid, with the usual slight variations in the different experiments; and a remainder of 10 azotic gas.

Oil-gas I find is not altered by being kept 2 or 3 years over water or mercury, either by itself or in mixture with 3 or 4 times its bulk of oxygen gas.

I have alluded to the absorbability of oil-gas by water: It may be of some use to give the results of one trial. Into a well stoppered bottle filled with 2700 grains of rain-water

having its due charge of atmospheric air, I put 102 water grain measures of the above (T. H.'s) oil-gas, being previously washed in lime-water. The bottle of water was briskly agitated for one or two minutes, occasionally relieving the stopper under water. On turning out the residuary gas there were 62 measures, which by analysis were found to consist of 27 azotic gas, 6 oxygen and 29 combustible gas, which last required 56 oxygen for their combustion. Again, into said water put 130 oil-gas: agitated well, there were left 80 measures, which by analysis exhibited 16½ azotic, 3½ oxygenous, and 60 combustible gas; these last required 110 oxygen for their combustion. In the next place, 108 oxygen of 93 per cent. purity, were put into the water and well agitated: Out 101 measures which by analysis consisted of 14 azote, 56 oxygen, and 31 combustible gas; which last required 83 oxygen for their combustion, and produced 52 carbonic acid.

Here it is obvious that the gas expelled from the water was richer than the original, or contained more superolefiant, both from the increase of carbonic acid and of the requisite oxygen.

Upon reviewing the whole of the experiments connected with this subject, I think it

is nearly demonstrable that oil gas is a mixture of carburetted hydrogen, carbonic oxide and hydrogen, together with a greater or less portion of a gas *sui generis*, consisting of the elements of olefiant gas united in the same proportion, but differing in the number of atoms. Most probably the atom of the new gas consists of two of olefiant gas; and the density or specific gravity of the new gas is greater than that of olefiant gas in the ratio of 4 or 3; or its specific gravity is 1. 293, atmospheric air being 1.

Consistently with this view the constitution of the last specimen of gas and its properties will be as exhibited below:

Constitution of Oil-gas prepared for burning.

	Sp.Gr.	Weights.	Give carb. acid.	Take oxyg.
7 Vol. carb. acid gas	1.53 ——	.1071	——	——
30 Vol. superolefiant	1.293 ——	.3879	..... 60	.120
40 Vol. carb. hydrogen	,555 ——	.2222	..... 40	80
6 Vol. carb. oxide	,970 ——	.0582	..... 6	3
7 Vol. hodrogen	,060 ——	.0056	..... —	3½
10 Vol. azote	,970 ——	.0970	..... —	—
100		.8780	126	206½

The differences between this imaginary constitution and the one observed above, either in the specific gravity of the mixture, the quantity of carbonic acid it would produce, or the

quantity of oxygen it would require for its combustion, are far too small to found any reasonable objection upon; especially as the analyses of such compound gaseous mixtures are scarcely ever made twice with precisely the same results.

SOME

OBSERVATIONS

UPON THE LOCAL PREVALENCE OF

IDIOTISM,

AND ITS CONNEXION WITH GOITRE.

BY KINDER WOOD, SURGEON.

Read Nov. 3d, 1820.

THE existence of an endemic Idiotism in parts of the globe far distant from each other, has been noticed by various travellers; but has attracted more particular attention in certain parts of the Alps, on account of its greater prevalence and more decided character in that region. In Switzerland, France, Germany and Italy, as well as in this country, the affection is known by the term Cretinism; but the appellation is more particularly esteemed to apply to the Idiots of the Alps

among whom it has originated. (*a*) It has been observed in the Pyrennees, among the mountains in the department of the Gard in France; in the Alps, and the Apennines; on the Tartarean side of the Chinese wall; and in the mountains of Bootan in the East, as well as in a long range of marshy wood at their foot. Some account of the affection, among the inhabitants of the Vallais, is given by Sir Richard Clayton in the third volume of the Transactions of this Society; further observations were published by Coxe a short time afterwards, in his account of travels in Switzerland, and succeeding travellers have noticed the Alpine Idiot with more or less attention. But as nothing of a similar kind has been hitherto noticed in our own country, I have thought the statement of an analogous circumstance, with some remarks, could not be uninteresting to the Society, especially

(*a*) On sait qu'on donne dans le Valais le nom de Cretins, à des imbécilles qui ont ordinairement de tres-gros goitres, et que cette maladie est endemique dans quelques vallees des Alpes.[***]. Dans la Vallée d'Aoste, où il y en a peut-être encore plus que dans le Valais, on les nomme *Marons*.

Vid. Saussure. Voyages dans les Alpes, Tom 2. § 954.

Dans quelques vallées, où ces maladies sont endemiques, on leur donne encore le nom de *Bienheureux*, et apres leur mort, on conserve, avec vénération, leurs béquilles et leurs vêtemens.

Fodéré. Traité du Goitre et du Cretinisme, 1.

since it occurs in the immediate neighbourhood.

In a part of the township of Oldham, called Sholver, my attention was called to the number of Idiots; I took a list of their names, which I shall take the liberty of reading. From Sholver-Moor, along the face of the hill, following its curvature at the Dog-hill to Crompton, and in the immediate neighbourhood, being an extent of about three miles, there will be found, or have lately existed, a greater number of these individuals, than in any other part of the country. The ground faces nearly west, is excessively exposed to the winds which cross the Irish channel, and sweep over the flat country loaded with vapour. The lower part of the hill is defended from these winds by Werneth and Oldham Edge, but as these high grounds, decline or terminate to the north they form with High-Crompton a trough or hollow, giving a direction to the currents, which accumulating rush up the valley over Royton and Shaw, to be intercepted by the hill we speak of, against which they break with considerable force. The ride along this hill is the most bleak and cold of any in the neighbourhood; the country is completely unsheltered by trees or hedge rows; the soil is thinly

scattered over the surface, and the herbage scanty. At the foot of this high ground is a long tract of moss, which has lessened of late years as an increasing population has made land more valuable; from this marshy ground, flow streams which contribute to form the sources of the Medlock, the Irk, and the Beale.

List taken 1817.

James Bradley, Sholver-moor, an Idiot about eight years of age.

Joseph Kershaw's son, Sholver-slack, an Idiot aged about nine years.

Robert Winterbottom, Roebucklow, an Idiot about 30 years of age. As these individuals are frequently deaf and dumb, I may also remark that a son of John Horsefield, of Roebucklow, is deaf and dumb; amongst this latter class of objects it is often difficult to ascertain whether diminished intellect is the effect of defective education, or irregular evolution of the brain.

John Shaw, near Doghill, has interred two idiotic children, the oldest lived to be twelve or fourteen years of age.

James Robishaw has also interred two idiotic children,

John Hague, an Idiot in the same neighbourhood, died a few years since more than twenty years old.

Robert Dransfield, Old-bank, is an Idiot about forty years old: Annice Dransfield his sister died a few years since: Thomas Dransfield his brother died aged about twenty-five years, both Idiots.

——— Crossley, Shore-edge, has three sons Idiots, the youngest though deaf and dumb, possesses intellect to a certain extent. The oldest is the most absolute Idiot I have ever seen.

Anne Crompton, Wood-end, has a child with defective intellect.

James Dawson, Green-hill, is an Idiot about 30 years old.

Jacob Platt, Dog-hill, had an idiotic son, who died about 30 years old.

——— Cheetham, Crompton, has an idiotic son.

John Higginbottom, at Beswicks, buried a daughter, an Idiot aged about nineteen.

I must observe of this list that some of the families are known to me personally; the ages attached to the names are approximations, and as near as are generally made in common life; there are more male than female

idiots; the deficiency of intellect varies in its degree, so that we have the complete and the partial Idiot; several families have produced two or three of these individuals; they are a class of beings generally of short life, and on this account many slip into an early grave without being noticed. As this list is composed chiefly of individuals who had overcome the serious diseases of infancy and childhood, it is certain that a more careful enquiry would extend it considerably, by bringing forward those who have escaped popular observation; it is however sufficiently large to ascertain the fact.

In the Alps, and the Appennines; in the Pyrennees, and the Cevennes; in Tartary, and in Bootan; and generally where Idiotism is endemic, that enlargement of the neck termed Goitre, consisting of tumour of the Thyroid gland is found to prevail. This tumour is found in many parts of England; it is frequently seen in the neighbourhood where the intellectual feebleness now spoke of is found. It is observed in Warwickshire, Norfolk, Lancashire, and more especially upon the hills in the county of Derby; its prevalence in the last named district is so great that it has acquired the name of Derbyshire neck, and is so known throughout

England; (*a*) Pilkington informs us that in the little village of Duffield there existed no less than fifty goitrous families. It is worthy of remark that the idiotism now introduced to the society exists upon a part of the same range of hills; a chain which commencing in Staffordshire, runs through Derbyshire, Yorkshire, Lancashire, Westmoreland, and Cumberland.

The goitrous tumour never attains the same magnitude in England, which it does in some other countries. In the Vallais it is stated by Coxe (*b*) to be occasionally the size of a peck loaf, and by (*c*) Watkins as hanging half way down the body. (*d*) Captain Turner in his embassy to Thibet, describes it as forming immediately under the chin, extending from ear to ear, and hanging from the throat down upon the breast. (*e*) Marsden also describes it in Sumatra as hanging

(*a*) View of the present state of Derbyshire, by J. Pilkington. p. 41.---1789.

(*b*) Travels in Switzerland, &c. &c. by William Coxe. 4th Edit. Vol. 1. p. 430.

(*c*) Travels through Switzerland, Italy, &c. &c. by Thomas Watkins. p. 38. 1787, &c.

(*d*) Account of an Embassy to the Court of the Teshoo Lama in Thibet, by Captain Samuel Turner. p. 86.---4to.

(*e*) History of Sumatra, &c. &c. by William Marsden. 3d Edit. p. 317.

from the neck the size of quart bottles. When the tumour is found thus large and combined with absolute idiocy, it never fails to be described by the traveller with the utmost horror and disgust, and when the situation of the Thyroid gland is considered, and its connexion with the Larynx and Trachea, it is surprising that death by suffocation is not produced long before so great a magnitude is attained.

The endemic which is the subject of this paper has not so far as I know been connected with goitre in any of the individuals or their families, although the goitrous tumour is frequently met with in the neighbourhood, particularly in young females, nor have these two affections been hitherto found connected in England except by accident. It ought to be stated that in the short account given by the writer of the article Cretin in Rees's Cyclopedia, we are told that some years ago a female Cretin of the name of Sothern resided at Hull, and another at Plymouth. The only case in which I have seen defect, in any part of the nervous system conjoined with Goitre, is in a young female at Hollinwood, who is deaf and dumb, with very considerable fullness of the neck. *(a)*

(a) Since reading this paper I have been furnished with some in-

We are told by (*a*) Fodere that cretinism and its different shades, are always an inheritance from the father or mother, or that one of the parents have a large Goitre. He has gone farther and stated, that if a goitrous male, son of a goitre and demi-cretin, marry likewise a demi-cretin, the progeny will be a complete Cretin. On the contrary if a male Cretin of the second degree, marry a healthy female, well formed and intelligent, the progeny will be a Cretin of the third

formation upon the subject, which I shall take the liberty of adding. It is contained in a letter from near Wirksworth, in Derbyshire, of which the following is a copy:---Dear Sir, Idiotism and the Derbyshire neck prevail much in the small village of Ireton-wood, near to where I reside; there are very few females free from the full neck, and as many as seven or eight Idiots. Two of these idiots have the Derbyshire neck, viz, Hannah Yeomans, and Sarah Hutchinson, the last named person has a daughter who is an idiot, but without the full neck.---Ireton-wood is situated in a warm valley open to the South. There is a person named Joseph Dean, resident in the village of Kirk-Ireton, an idiot with the full neck, but the affections are not prevalent there.---The full neck as well as idiotism appear to prevail in particlar families, but as far as I am able to judge, are not governed by situation, so far as regards hills, rivers, &c. &c. High winds and frequent rains do not prevail in this neighbourhood. I am, Sir, &c. &c. R. Cresswell.—— The above communication is a very clear and perspicuous statement of the personal observations of the writer: it shews the existence of the true cretin, or goitrous idiot in Derbyshire; it shews also that idiotism, and goitre, exist to a considerable extent simply and uncombined; it confirms the general observaton that goitre is most frequent in females; and it contradicts the statement of Pillsington that high winds are very prevalent.

(*a*) Traite du Goitre et du Cretinisme. Par F. E. Fodere. 8vo. Paris. p. 136. et 138

degree; and if healthy females still marry into this family, the intellectual feebleness will disappear. If these statements are really founded upon accurate observation, they are highly curious, and establish the connexion betwixt goitre and cretinism; but there is some reason to doubt their accuracy. If such a decided and perceptible connexion existed, idiotism which is stated to be the effect should be observed wherever goitre is found prevalent, but this is contrary to fact; goitre is found in many parts of England without any endemic idiotism; we are told by *(a)* Dr. Reeve that this is the case in the county of Norfolk; and at Duffield where *(b)* Pilkington notices so very extensive and prevailing a goitre especially among the females, he does not even allude to the existence of idiotism. *(c)* Dr. Bright found goitre extensively near Perlac in lower Hungary, but does not speak of any deficiency of intellect existing, and *(d)* Marsden describes goitre in the same manner, in the island of Sumatra, without any allusion to the existence

(a) Some account of Cretinism, by Henry Reeve, M. D. see Edinb. Med. and Surg. Journal, Vol. 5. p. 31.

(b) View of Derbyshire, by J. Pilkington. Vol. 1. Chap. 2nd.

(c Bright's Travels in Hungary &c. &c. 4to.

(d) History of Sumatra. p. 48.

of an endemic idiotism, he even states that the goitrous tumour is compatible with the highest health in other respects. Again, if the existence of goitre in father or mother leads to a progeny possessing a defective intellect, the effect should be constant, and the whole progeny should be thus affected; but this is not the case, for we are told by Coxe, (*a*) that they are sometimes the offspring of healthy parents, whose other children are properly organized, and who are themselves free from guttural swellings. I know several goitrous females, married, whose progeny are properly organized and intelligent, and I also know two goitrousmales, married, whose families are of sound mind.

If then numerous cases of idiotism occur without goitre, and goitre without idoitism; if goitrous individuals produce a progeny having sound intellect, and if idiots are frequently the progeny of parties not idiotic or goitrous, as in the endemic before us, it must be allowed that the alleged connexion betwixt these

(*a*) Travels in Switzerland, Vol. 1. p. 430.

See also Saussure. Tour 2. Chap. 48. § 1031. Il paroit que c'est surtout dans l'enfance, dans cet âge ou la fibre est tendre et flexible, que se détermine cette maladie; car ceux qui en ont été exempts jusqu'á leur huit ou dixieme année, le sont également pour toute la vie. Les étrangers qui viennent s'etablir dans le pays ne la prennent jamais, mais leurs enfans y sont sujets comme ceux des indigenes.

two affections so often intimated by travellers, and which Fodere has endeavoured to establish, must be considered as more than doubtful and uncertain.

Considering the connexion of these affections in the most simple point of view, as two distinct endemics appearing in the same local situation, it may still be asked how their frequent conjunction in the same individual is to be accounted for? In this circumstance there is nothing new, nor at all contrary to our experience of the co-existence of disease; it only seems to shew an intimate connexion betwixt their causes, if it does not shew them to be the same, whilst the effect is influenced by the habits, tendencies, and predispositions of the individual exposed to their action; it is this absence of predisposition which enables so many to remain in perfect health though exposed during a long life to causes, which in other habits produce the most injurious consequences.

It might be thought that physical causes producing an influence thus powerful over the developement of the mind and the body, could be easily ascertained, but this is not the case. Many of the ascribed causes are inadequate to the effect, or must produce it more generally; whilst others are at vari-

ance with well known facts. The modification of cutaneous diseases in passing through a variety of habits; the abuse of spirituous liquors; want of cleanliness and ventilation in habitations; scanty cloathing; coarse food; and the drinking of cold water are evidently of too general a nature, to produce a particular and local effect. Heat of the climate and stagnation of the air, considered as causes by Saussure (*a*) are at variance with common observation, since these affections are frequently observed in situations exposed to cold, wind, and moisture. The disease is endemial among some tribes of the Stone and Cree Indians inhabiting the banks of the Saskatchawan river, where it was observed by Dr. Richardson (*b*) in his journey to the Polar sea; the country is open, desert, and extremely cold, it consists of "one vast plain whose boundaries are imperfectly known, it extends along the south branch of the Missouri and Assenaboine rivers, being

(*a*) Je crois donc qu'il faut chercher la cause de cette maladie dans quelque modification qui soit exclusivement propre aux vallées peu élevées au dessus du niveau de la mer. Or, je ne vois rien qui satisfasse à cette condition, sice n'est la chaleur et la stagnation de l'air renfermé par les montagnes qui entourent ces vallées.

Saussure. Chap. 48. § 1035.

(*b*) See A Journey to the Shores of the Polar Sea, &c. by Captain John Franklin. 4to. 1823. p. 116. 118. 119.

interrupted through the whole of this great space by few hills or even rising grounds." We have equal reason to deny the origin of these diseases in the use of snow-water, since goitre is found in the island of Sumatra where snow never falls; whilst among the Indian tribes at a distance from the Saskatchawan the disease is unknown, although melted snow forms their only drink for nine months of the year; the same exemption is enjoyed by the inhabitants placed at the foot of the Glaciers of the Alps. (*a*) It has been stated that water holding mineral bodies in solution was a source of these appearances, but these substances are easily detected in the waters of any district, and the action of individual minerals upon the animal œconomy are well known, and are different from the appearances presented in the derangements we are considering. That the whole of these affections are produced by earthy matter contained in the water, has gained a very popular acquiescence; it is alluded to by Watkins and Sir Richard Clayton as well as by the generality of travellers. Coxe has been at some pains to confirm the impression, and his statement

(*a*) See Coxe and Fodere. Saussure also, on ne voit des Cretins, ni dans les hautes vallées, ni dans les plaines ouvertes de toutes parts. Chap. 48 § 1033.

that a surgeon in Switzerland informed him, that he had extracted earthy concretions from the goitrous tumour, has contributed materially to make the opinion more popular. Small portions of earthy matter may possibly be deposited in the cells of the Thyroid gland, as we frequently see it occur in various other parts of the system; but the circumstance in this organ is extremely rare, being unnoticed by medical writers. Goitre in its commencement appears to be an accumulation of blood in the vessels, which in a more advanced stage relieve themselves by pouring a viscid mucus secretion into the cells of the (*a*) gland; an enlargement of the Thyroid gland from vascular fullness, is not uncommon with new born infants, which early subsides without medical treatment. In further opposition to this opinion supported by Coxe, I shall remark that the disease was observed by Dr. Richardson (*b*) to be most prevalent, near to the source of the river, upon whose banks

(*a*) In Baillie's beautiful engravings of Morbid Anatomy is a section of a goitrous Thyroid, and also a view of the enlarged gland encircling the Larynx and Trachea. "In this disease the gland is much enlarged "beyond its natural size, and formed into a great number of cells con- "taining a very viscid fluid. This fluid becomes solid like a jelly when "the gland has been kept sometime in proof spirits." *Vide Fascicul 2d. plate 1st.*

(*b*) See Franklin's Journey, p. 118.

it was found, and where the water was most pure: that as the river continues its course below Edmonton, through plains whose soil is alluvial and calcareous "it becomes turbid "and acquires a white colour; in this state it "is drank by the inmates of Carlton house, "where the disease is known only by name."

By actual observation and experiment (*a*) Fodere has shewn that goitre and cretinism are most frequent in the deep alpine vallies, washed by torrents, having a marshy bottom and exuberant vegetation: he examined the atmosphere of these vallies with an hygrometer and uniformly found the number of these unfortunates, to be in proportion to the humidity of the atmosphere in which they resided. The vallies of the Pyrennees, and the Appennines, present the same features, and are attended with the same consequences: (*b*) Sir George Staunton remarks that the high grounds in Tartary where he noticed similar appearances, presented many alpine features; and (*c*) Turner more careful in his description, not only found these affections

(*a*) Traite du Goitre et du Cretinisme. par F: E: Fodere. Troisieme section. De la cause generale du Goitre et du Cretinisme.

(*b*) Account of the Embassy to China. By Sir Geo. Staunton. 8vo.

(*c*) Turner's Embassy to Thibet. p. 67.

in the mountains of Bootan, but extensively in the woody belt which encircles their foot to a depth of from ten to twenty miles, which forest abounds with marshes from which originate the rivers flowing to the south. *(a)* Pilkington also informs us that in Derbyshire where goitre prevails he perceives nothing peculiar but high lands, high winds, and heavy rains. Perlac, in Hungary, where *(b)* Bright found goitre, lies in the low land betwixt two large rivers; and we are further told that the Hungarian peasantry have their crops frequently ruined by heavy storms of wind and rain. The statement before made of the ground where the idiots now introduced to your notice are found, shews analagous features; it is exposed to the accumulated force of the west and south-west winds, which prevail the most and are frequently loaded with moisture; whilst a tract of marsh land lies at its foot, giving rise to three streams ultimately falling into the Irwell.

These affections have been thought peculiar to hilly and mountainous districts, and it is true they are most frequently seen in such situations; in some of the instances alluded

(a) View of the present state of Derbyshire. Vol. 1. Chap 2d.

(b) Bright's Travels in Hungary, 4to.

to they are found in low grounds; but in all countries where they have been noticed, they have been attended with the concurring circumstance, of a great humidity of the atmosphere.

When circumstances thus uniform, are attended with appearances thus similar, we cannot withold our assent from the opinion, that they stand in the relation of cause and effect to each other. But of the manner in which this influence is exerted upon the constitution we are entirely ignorant, and we can only further contemplate it, in its effects. The dissection of the brain of young idiots might lead to some earlier steps in the investigation, but I am not aware that this has been done.

In examining the heads of these individuals, we find them present a configuration very similar, to that of children labouring under chronic hydrocephalus, and also to the heads of children having early and large evolution of the brain; indeed it seems to be actually the case in simple idiotism and cretinism, that the cerebrum evolves itself prematurely; hence we find the idiot possessing a large head with a small face, frequently a flat crown with large frontal and parietal protuberances, all of them circumstances which

occur in the hydrocephalic, and in children possessing premature mental powers.

(*a*) Dr. Reeve has given a drawing of the head of a cretin who died aged thirty years, and has noticed some curious facts; the anterior fontanelle was not closed; the os occipitis was very large, with numerous ossa Triquetra in the lambdoid suture; the temporal bones were imperfect, and the second set of teeth not out of their sockets. In the face, the maxillary, cheek, and nasal bones were not completed. The head was very large, and the face small, resembling the skull of an adult upon the face of a child. This statement shews defective and irregular ossification of the bones of the head, and it is curious to observe in this as well as many other instances how very much bony formation is impeded, by defective organization of the brain.

When the inside of the skull has been viewed, equal defects have been found at the base: (*b*) the large holes situated betwixt the cuneiform process of the occipital, and the petrous portion of the temporal bones, through which pass the eighth pair of nerves, the ac-

(*a*) Edinburgh Med. and Surg. Journal. Vol 5.

(*b*) Vide Fodere. Traite du Goitre et du Cretinisme. p. 144.

cessory nerves, and the blood from the lateral sinuses, were observed diminished in size; the cuneiform process was void of its natural concavity: and thatportion of the occipital bone which contains the cerebellum was diminished nearly two-thirds in size. All the circumstances enumerated lead to the opinion that the cerebrum is prematurely and largely developed, whilst the cerrebellum and medulla oblongata are lessened and defective in their organization.

It has been thought that the formation of the cranuim influenced the developement of the brain; but there are numerous facts which shew, that the formation of the cranium is completely modified by the changes which the internal organs undergo. It is to allow this adaptation of the coverings to the part covered, which constitutes a necessity for the sutures; and it is owing to them that various changes of configuration take place in childhood and youth without destroying life, which could not occur after the sutures are closed.

The contracted state of the holes at the base of the cranium, and particularly the openings through which the blood passes from the lateral sinuses, seem to shew that the nerves transmitted through them are small,

and therefore that the brain is in a state of feeble action: the same irregularity shews a diminished supply of blood, because the holes for the exit of blood must correspond to those for its entrance, otherwise such congestion would take place in early life as to destroy the individual so formed, either by the rupture of a vessel, or by the effusion of water into the ventricles, or upon the surface of the brain.

In considering these great defects in the conformation of the brain, it is no wonder that we see the intellect wholly or partially destroyed, whilst the vital and animal functions are carried on in a very imperfect manner. Defective organization of the brain, is attended with irregular evolutions and powers in various other parts of the animal economy; and the Idiot though well formed in infancy and childhood, becomes deformed, and in many instances distorted as he approaches to puberty; and I apprehend that it will be generally found, in examining the gradations of idiotism, that the defect of figure and the defect of intellect, will correspond with each other.

OBSERVATIONS in METEOROLOGY,

PARTICULARLY WITH REGARD TO THE

DEW-POINT,

Or quantity of Vapour in the Atmosphere;

MADE ON THE MOUNTAINS IN THE

NORTH OF ENGLAND,

From 1803 *to* 1820.

BY JOHN DALTON, F. R. S. &c.

(Read Feb. 9th, 1821.)

IN my paper on Meteorology, vol. 3, page 509, I mentioned my intention of drawing up a memoir on the subject of vapour or steam in the atmosphere, particularly with regard to the idea of a distinct vapour atmosphere, mechanically blended with the common one, but acting by its own tension or elasticity, and being subject to condensation by cold exactly in the same manner as an insulated atmosphere of steam would be. The following collection of observations and

remarks are presented to the Society pursuant to the said intimation.

The notion of an aqueous vapour atmosphere as an agent distinct from the general atmosphere, was first announced by me in the paper on the constitution of mixed gases, read in October, 1801, and published in the 5th volume of the Memoirs, part 2d.—Now if an aqueous vapour atmosphere, such as just mentioned, exist, it must be subject to the same laws as the atmosphere at large; that is, it must decrease in density in ascending in a geometrical progression to increments of height in arithmetical progression; or at least it must constantly be tending to that state.

In order to investigate this fact, it would be desirable to ascertain the density of vapour at the heights of 1, 2, 3, 4, &c. miles above the earth's surface. But as this is scarcely practicable, especially in this country; it occurred to me that observations made at such heights as are easily attainable would have their use, in as much as they would at least countenance if not demonstrate the idea I entertained, or else the reverse.

As I had for some years been in the habit of allowing myself a week or two in summer for relaxation from professional engagements, and had generally spent the time in breathing

the salubrious air of the mountains and lakes near my native place in the North of England; it was therefore an additional gratification to be enabled to unite instruction with amusement.—I began my observations relative to this point in 1803, and have continued them almost in every successive year to the present.

The principal mountain on which the observations were made was Helvellyn, on the confines of Cumberland and Westmoreland; but most or all of the other high mountains in the vicinity have occasionally served my purpose. Helvellyn is the highest mountain of a long range running nearly from N. to S. for eight or ten miles. The high road passes close upon the foot of it. The ascent for the first half is very steep, for the last half it is a pleasant gradual slope. The mountain is mostly covered with a dry green turf, but there are several huge rocks and precipices, and in places many beds of loose stones. A copious stream of water, collected from several fine springs in the upper part of the mountain, descends the west side of it, in rainy seasons forming an almost continuous series of cascades, which has a fine appearance from the valley.—I have had a portable barometer not less than seven times upon the summit, and can fully answer for the accu-

racy of the barometrical variation between the valley of Wythburn at the foot, and the summit of the mountain. From the road at the Nag's Head public house to the top of the mountain the barometer falls usually in the month of July 2.62 inches: it has never with me been less than 2.58 nor more than 2.68, whatever was the state of the atmosphere as to pressure and temperature.

From barometrical results I calculate the height of the road at the foot of the mountain to be 180 yards above the level of the sea: also the summit of the mountain to be 850 or 860 yards above the road, making a total of 1035 yards perpendicular elevation above the sea.

On the opposite side of the valley to the west is a parallel range of mountains, about a mile distant, and half the height of the Helvellyn range; beyond these are other mountains, but of no great altitude, till the distance of eight or ten miles, when they are again high. The east side of Helvellyn from the summit a considerable way down is exceedingly steep, so that the summit is scarcely accessible on that side; beyond, the mountains gradually fall to an extensive plain.

The usual mode of my operations was to find a spring on the side of the mountain;

then to take a cup of water from it and pour into a clear dry tumbler glass; if dew was produced immediately on the outside of the glass, the water was returned into the cup and the glass was again carefully dried outside. During this time, the water in the cup was acquiring temperature from the air. It was then returned into the tumbler and held out exposed to the current of air. This process was repeated till no dew was found to be formed on the glass. The temperature of the water each time it was put into the tumbler was found by a small pocket thermometer; and *that* when it last produced dew on the glass was marked down as the dew-point. At the same time the barometer was noted, to find the height of the place of observation, the thermometer to find the temperature of the air; and the temperature of the springs was an object not wholly devoid of interest.

Difficulties however sometimes occurred. Springs were not always to be found where they were wanted; and many times when found the water was not cold enough to produce dew. In such cases a tea-spoonful or two of pounded nitre and sal-ammoniac were thrown into the water and stirred about till dissolved; this generally succeeded. On two or three occasions large *snow-drifts* were

found on the north-east side of the summit, which, being accessible, were particularly useful for the purpose of reducing the temperature of the water, especially as it was easy to carry a quantity of it in a basket, and preserve it for a day or more.

1803.—*Observations on Helvellyn.*

(Weather fine and sunny.)

July 27th.		Height above the adjacent valley & lake, in yards.	Temp. of air.	Dew-point.	Temp. of Water
1 P. M.	Summit	855	55°	46°	—
1½	Brownrigg-Well	745	57	49	42
2	Lower Spring	525	61	50	46
2½	Another do.	230	65	52	50
4	In the Valley	0	70	53	—

—o⌒o—

1805.—*Observations on Coniston Fell.**

(*This Fell is about 860 yards above the level of the sea; and about 820 or 830 above Coniston Lake, from which it is distant above a mile to the westward. It is higher than any hill in the immediate vicinity, but there are several higher six or eight miles to the north.

July 16th. About 11 o'clock, clouds in contact with the Fell, but soon rose and exhibited light clouds above the summit the rest of the day.

	Ht. above the lake, in yards.	Temp. of air.	Dew-point.	Temp. of Water.
2 P. M. Summit	820.....	54°.....	47°.....	—
3 ..... First Slate Quarry descending }	500.....	60	48	45°
5..... Coniston Lake..... }	0.....	66	50	—

—o.o—

1806.--*Observations on Kentmere High-Street.**

(*This Fell is about 900 yards above the Sea: it is situate on the S. E. side of the immense group of mountains surrounding the Lakes; it lies about 10 miles north of Kendal. The vale of Kentmere is about 150 yards above the Sea.)

July 16th. Day fine.

	Ht. above the vale, in yards	Temp. of air.	Dew-point
Summit	750.....	45°.....	37°
Another Summit	660.....	47	38
Kentmere	0.....	55	45

—o.o—

1809.—*Observations on Great End.**

(* This Mountain is about 1000 yards above the sea: it is situate at the end of Borrowdale and is surrounded by the highest mountains of the North.)

July 12th.—1 P. M.—On the summit for an hour or two; but completely enveloped all the time in a thick fog: the air and the dew-

point both at 52° It was with the greatest difficulty the guide and I found our way down, as we could not see objects more than 20 yards before us. The wind was strong, and we trusted to it as a guide, knowing its direction. The fog became rain below and we could see better. It was a fine hay-day in the country around.

July 14.—*On Helvellyn.*

	Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
6 P.M. Summit.....	855.....	48°.....	48°.....	—
Mist and small rain.				
..... Brownrigg-Well	745.....	48	48	41°
7½..... In the Valley	0.....	57	55	—
Clouds about 200 yards up the mountain, and raining below.				
July 15. Morning, in the valley	57	54	—	
Raining: clouds about 300 yards up the hill.				

—o⌒o—

1811.—*Observations on the Pikes of Broad Crag.**

(* This is the highest Land in the North of England. It is the middle of a range beginning with Great End at the North, and proceeding South till it ends with Sca-fell. Height, about 1100 yards.

July 2d.—Morning pretty fine, but some distant thunder heard as we began to climb. We arrived at one of the Pikes, but the fog

set in so dense that we were detained there for an hour or more; at last a sudden gleam of sun broke through and gave us a view of the highest Pike, about half a mile off: with great haste we got to it before it was again concealed, so as to take the barometrical and other observations. The barometer stood at 26.7; the thermometer was at 55° in the fog, and consequently that was the dew-point at the same time. At one time we separated a little, and the mist coming on suddenly we lost one another; some called out, and were led astray by the echo, thinking it was their companions answering the call.

N. B.—We left Low-wood Inn early in the morning, when the lake Winandermere, and the surrounding country were covered with a dense fog, but the sun was just visible through it. At 6 A. M. I observed the temperature of the air to be 60°, whilst that of the lake was 66 and the air calm. Hence the mist was easily accounted for. Next day at 10 P. M. the air was 46° and the Lake 58°, that is 12° higher, but there was no fog on it, because there was a strong breeze.

We learned a few days after, that there was a great thunder-storm in some parts of Cumberland and Westmoreland, the adjacent

counties, during the time we were on Broad-Cragg Pikes; we heard no thunder except one clap at 9 A. M. as we were beginning the ascent.

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1812.—*Observations on Helvellyn.*

July 6th.—A fine day, but cool for the season. Light, fleecy clouds above the summit.

		Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
3½ P. M.	Summit	855	46°	42°	—
	Brownrigg-Well	745	—	42½	42°
	Another Spring	650	49	43	—
	Another Spring	420	—	43	47
5½	In the Valley	0	56	46	—

At this season I found for the first time a large snow-drift on the N. E. side of the summit in a deep ravin. It measured about 20 yards by 30, and was 3 or 4 yards deep in places: a hard compact mass, so that standing upon it made no impression. I took a quantity down and found the dew-point in the valley frequently to be 46.

*Observations on Sca-Fell.**

July 8th.—Foggy on the mountain till 3 P. M.; after fine and sunny.

(* This is the South end of the high range of Pikes. It is only a part of a mile from the highest point of Broad Cragg; but it is almost impossible to pass directly from one to the other, from a deep chasm in the range. We ascend this mountain from Wasdale. Its height is somewhat less than the highest pike: it may be stated at 1050 yards.)

10 A. M. Wast-water—Head of the Lake—air 66°

		Ht. above the lake Wast-water, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
11¼....	A Spring	300.....	63°.....	55°.....	48°
12½....	Another Spring	550.....	60	56	43
2 to 4 P.M.	Summit	1000.....	56*.....	56	—
5¼.....	Another Spring	700.....	66	56	42
6¼.....	Another Spring	400.....	64	60	48
7½.....	Wast water Lake.	0.....	64	60	—

*In fog at first, 60° when sunny.

Remark.—When we arrived at the summit, and for some time previously, we were involved in a thick fog. It continued for an hour or more, though we could at intervals see the sun through it. I was about to conclude, from repeated experience, that this range of high Pikes was eternally covered with fog. In time however the sun burst through, and

a fine breeze from the west contributed to dissipate the fog; so that in the space of 20 or 30 minutes we had to extend our vision from the confines of a few rocks at 50 or at the furthest 100 yards off, to the limits of the horizon where the sea and sky met, which was some distance beyond the Isle of Man, where the glistening of the sea was conspicuous. Several ships were seen at sea, and the whole western view was as fine and clear as possible.

July 9th.—Observations on the ascent from Wasdale to Stye-head and over the mountains to Langdale.

The intercourse between Wasdale and Langdale is by a road which rises almost to the height of the first-rate mountains. At the highest place it is 760 yards above the sea; and it is remarkable, that place is the finest part of the road, being a smooth, green, level plain. It is said that horses have been led over from one valley to the other; but it is excessively steep on the Langdale side.

From Wasdale the first part of the road is the ascent to the Stye-head; which is tolerable horse road. The height is 475 yards above the sea. To this place the roads from Wasdale to Borrowdale and Langdale unite:

afterwards the road descends straight into the former, but turns to the right and ascends again to the latter, close under Great End, till it arrives at the green summit above-mentioned; after which it descends towards Langdale.

	Ht. above Wast-water Lake, in yards.	Temp. of air.	Dew-point.	Temp. of Water.
8 A.M. Road to Stye-Head: a Spring	320	60° fog.	58°	48°
9 ..... Stye-Head	450	60 foggy.		
9½..... Under Great End.....	600	..... fine clear air.		

At this place the sun shone, and the tops of the mountains were clear; but a body of fog was seen to ascend up the gap at Stye-head, out of Wasdale, where meeting with the sun's rays and spreading on an extended plane, it gradually wasted away. So that a volume of fog was pouring out incessantly for an hour or more, like a dense cloud; but if any particular parcel of it was pursued by the eye, it was found to vanish or dissolve in the space of a few hundred yards. It resembled the jets of vapour from a steam-engine boiler into the air.

1816.—*Observations on Helvellyn.*

July 8th.—Fine and sunny, but cold for the season.

		Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
1¼ P.M.	Summit.....	855.....	51°.....	45°.....	—
2	Brownrigg-Well....	745.....	—	47	42°
2¼.....	Another place	500.....	—	47	—
4	In the Valley	0.....	—	50 or 51	—
9	Low-wood Inn	0.....	57	49	—
	Next Morning	0.....	55	50	at Low-wood.

N. B. There were two large snow-drifts on Helvellyn; and others were seen on the mountains. Took some down with me and kept it for experiments at Low-wood and at Keswick.

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1818.—*Observations on Helvellyn.*

July 7th.—Morning rainy: mid-day cloudy and some showers of rain and hail: evening a thunder storm over great part of the counties of Cumberland, Westmoreland, and Lancashire.

		Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
Noon.	In the Valley	0.....	65°.....	—.....	.....60°
2¼ P.M.	Summit.....	855.....	52	—.....	—.....
3	Brownrigg-Well.....	745.....	55	.....48°.....	42
4¼.....	In the Valley	0.....	65	.....55	—.

Remarks.—When at the summit, or just before, we had a hail-shower; clouds in various strata, some above and others below the summits of the mountains—very wild and threatening appearance—a great snow-drift in the usual place. Got the cramp in my feet by standing on it a short time. A gentleman and his two daughters were in company with me in this ascent. Soon after our descent, which luckily was without rain, we posted to Keswick, and on the road at 6 P. M. encountered a tremendous thunder-storm. On going into Keswick the rain was heavier than I ever remember.

—o⌒o—

1819.—*Observations on Helvellyn.*

July 5th.—On the mountain from 2 to 5 P. M.: sunny, but a haze to the windward towards the evening.

	Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
5¼ P. M. Summit	855	54°	40°	—
5 Brownrigg-Well	745	—	44	42?
6 Do. descending	—	—	43 or 44	—
4 P.M. Another Spring	500	—	46	44
6¼ Do. descending	—	51	44	—
——— Another place	300	—	45 or 46	—
7 to 8 In the Valley	0	60 to 62	50	—
July 6. Morning. In the Valley		49		—

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1820.—*Observations on Helvellyn.*

July 17th.—Day gloomy: some drops: when on the summit a thick gloom above and flying clouds: wind N. E. strong.

	Ht. above the adjacent valley & lake, in yds.	Temp. of air.	Dew-point.	Temp. of Water
4¼ P.M. Summit	855	51°	47°	—
3¼ A Spring	500	56	52	45°
4 Brownrigg-Well, ascendg.	745	54	49	43
5 Do. descendg.	—	55	49	—
Another place 4 or	500	56	53	—
6¼ In the Valley	0	65	54	—

N. B.—The fog came down the mountain after me, but not so as to overtake me. It was half down the hill in the evening; and at 8 P. M. raining, with thermometer 60°

1820.—*Observations on the Pikes of Broad Cragg and Great End.*

July 19th.—Day generally fine and sunny.

		Ht. above Derwent Lake, in yards.	Temp. of air.	Dew-point.	Temp. of Water.
10 A.M.	Under Great End	700	59°	52°	51°
10½	A Spring above	850	60	54	49
11½	Summit of highest pike	1000	52 foggy	52	—
1		——	56 gleamy	—	—
2		——	57 sunny	—	—
4	West Pike of Great End	870	57 sunny	52	45
5	Great End	900	56*	—	—
6	A Spring above Sprinkling Tarn	600	56	53	45

* On the ground, 62° in the air.

Remarks.—When we arrived at the highest summit of the Pikes there was fog flying about it so as to obscure the prospect—and there was another stratum of clouds above. In an hour or more the fog cleared off, and the view was admirable; it was the more gratifying as I had not enjoyed it the former visit. We saw Low-wood Inn, about half of Winandermere Lake, half of Wastwater, and nearly the whole of Derwent Lake; besides a most delightful view of the mountains and distant country.

[The following Observations are added since the paper was read.]

1821.—*Observations on Helvellyn.*

July 9th. Weather gloomy, a breeze from the north.

H.	M.		Ht. above the valley, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
4	P.M.	Summit	855	50°	—	—
5	20	Brownrigg-Well.....	745	—	45°	41°
8	—	In the Valley	0	56	49	—
July 10th.		9 A.M.....	0	—	49	—

—o⌒o—

*Observations on Great Gavel.**

(*This is a bold mountain rising on the north side of the Gap (Stye-head) betwixt Wasdale and Borrowdale.)

Took a circuitous ascent from the road betwixt Borrowdale and Buttermere.

July 11th.

H.	M.		Ht. above Derwent Lake, in yards.	Temp. of air.	Dew-point.	Temp. of wat.	
1	45	P.M. Pointed Summit†	700				Air foggy with gleams alternately. Thermometer in a fog, 55°, laid on a rock 59°; soon after in a thick fog 50.°
4	—	Summit of Great Gavel.	900	50°‡	46°	—	
4	40						

Left the summit at 6½ P. M.: evening fine and sunny.

7½		.....Well....‖	300	—	50	48°	

The Dew-point varied from 49° to 54° the ensuing week in the plains below.

† South of Honister Crag, having Buttermere and Crummock Lakes in view nearly in a line.

‡ Thermometer held up in the flying mist; but 56° laid on a rock.

‖ In descending from Stye-head into Wasdale.

1822.—*Observations on Helvellyn.*

August 7th. Dew-point 55° in the circumjacent country.

Aug. 8th.	Ht. above the valley, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
6¼ P.M. Confluence of 2 streams*	500	53°	47°	51° N. 52 E.
6¼ Brownrigg-Well	745	47	43	42
7¼ Summit	855	45	40¼	—
8¼ A Gate	200	54	51	—
9 In the Valley	0	57	52	—

Weather.—Air clear, but cloudy in the west horizon. In company with Mr. Otley.

1823.—*Observations on Helvellyn.*

July 5th.	Ht. above the valley, in yds.	Temp. of air.	Dew-point.	Temp. of Water.
3¼ P. M. Summit	855	42°	40°	—
4 Brownrigg-Well	745	45	41	41°
5 In the valley	0	—	48	—

Weather.—Gleamy in ascending, cloudy in descending. In company with Mr. Charles Henry.

N. B.—At this time there was a large snow-drift in the usual place, about a quarter of a mile north of the summit, filling a deep sloping ravine facing the N. E.—The quantity was estimated at 30 or 40 cubic yards.

* In ascending from the Inn at Wythburn and keeping to the water-course on the left, we come, at the elevation of 500 yards, to the confluence of two primary streams; one from the north descends from Brownrigg-well; the other from the east comes from one or more springs not quite so elevated. Their temperatures just above the junction were observed as by the table.

Th isends the series of observations on the mountains; which I may perhaps be allowed to say are original in their nature and design. Though they do not demonstrate the existence of an atmosphere of vapour that is perfectly conformable to the known laws of the common atmosphere at large, they seem to establish several important points.

1st. That the quantity and density of vapour is constantly (or with very rare exceptions) less the higher we ascend.

2d. That wherever a dense cloud or fog exists, there the temperature of the air and the dew-point are the same.

3d. That when a mountain is wholly or in great part enveloped in fog, there is little variation in ascending either in the temperature of the air or in the dew-point.

4th. That upon an average the temperature of the air sinks after the rate of 1° for every 80 yards perpendicular ascent, about the middle or warmest part of the day; and that of the dew-point 1° for every 130 yards perpendicular ascent.

5th. That the phenomena of *aqueous meteors*, such as *rain*, *fog*, *dew*, &c. depend upon the known relations of heat and water, and are exhibited to us in miniature every day in our domestic economy. Electricity

appears to be a consequent rather than an agent in the formation and decomposition of clouds; or if a necessary agent it is equally so in the boiling of water or in the drying of piece-goods in a stove.

General Observations.

As the dew-point and temperature of the air approximate in proportion as we ascend, at some height they must become the same; and hence the cause why the upper regions of the atmosphere are so frequently clouded; also why the mossy summits of the mountains are generally moist.

From occasional observations on the dew-point for 20 years past, chiefly at Manchester, I have once observed it as high as 64°, once 63°, five times 62°, thrice 61°, and twenty times 60°, mostly in the months June, July and August. Its usual range is from 50 to 60° in those months.

The following little Table may have its use perhaps: the numbers exhibit the *drying power of the air*, according as its temperature is elevated above the dew-point. The Table is derived from that of evaporation. (Memoirs, Vol. 5, p. 685.)

Dew-point.	Temperature of the air above the dew-point.									
	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°
30°	8	16	24	32	41	51	63	74	86	98
35	9	17	26	37	48	61	72	85	99	114
40	10	22	33	45	57	71	85	100	117	135
45	12	24	37	51	66	81	99	117	135	154
50	14	28	43	60	78	96	115	135	155	178
55	16	33	51	69	88	109	131	155	181	209
60	18	37	57	77	100	126	153	182	213	244

Tables

OF

THE VARIOUS SPECIES

OF

PERIODICAL BIRDS

OBSERVED IN THE

Neighbourhood of Manchester:

WITH A FEW REMARKS

TENDING TO ESTABLISH THE OPINION THAT THE PERIODICAL BIRDS MIGRATE.

BY MR. JOHN BLACKWALL.

(Read before the Society Jan. 21, 1822.)

AN accurate and comprehensive history of the periodical birds may now be considered as one of the greatest desiderata in ornithology. Hitherto, little has been done to elucidate the habits, manners, and economy of this interesting portion of the feathered tribes, as connected with their periodical appearance and disappearance; for although much has been written on the subject, few facts of any considerable importance have been ascertained; and even these few lie

scattered through the writings of such various authors, and are so blended with what is erroneous or merely conjectural, that it is no easy task to distinguish and collect them: consequently our knowledge of the circumstances that regulate the motions of the numerous species of periodical birds, is still very limited; and we are almost entirely ignorant of the places of their retreat, and of the mode of their existence in those retreats. Whether, when they withdraw, they depart from those districts and countries in which they cease to appear, or whether they conceal themselves, and remain in a state of torpidity, has not yet been positively determined; and opinions must continue to be divided on the subject, so long as authors indulge in fanciful speculations, instead of contenting themselves with collecting and arranging well authenticated facts, from which alone legitimate conclusions can be deduced.

The accumulation of facts, then, appears to be the most important object to be attained at present, and my principal motive for introducing the following tables and remarks to the notice of the Society, is the hope that they may be found to contribute, in some degree, to increase our scanty stock of in-

formation on this obscure branch of natural history.

It is remarkable, that almost all the catalogues of periodical birds with which I am acquainted, have been formed from observations made in the South of England. This circumstance is certainly calculated to give additional interest to the following tables, made in so northern a county as Lancashire. In forming them, I have ventured to deviate a little from the usual mode of arrangement, having separated those birds that are irregular in the times of their appearance and disappearance, and those species also that are periodical in particular districts only, from the regular summer and winter birds, and have classed them under appropriate heads. I have, however, retained the wheat-ear, whinchat, and stonechat among the summer birds, and the snipe among the winter birds; for though individuals of the three former species frequently remain through the winter in the southern counties, and though numbers of snipes breed with us annually, yet the periodical appearance and disappearance of a very large proportion of these birds cannot, I think, be questioned. It may be urged, that the three species of wagtail ought to be removed from among the birds that are partially periodical,

where I have placed them, for the same reason; and perhaps it would be more correct to class the pied and yellow wagtails with the summer birds, and the grey wagtail with the winter birds; though the pied species is frequently seen in winter, even in the northern counties, when the season is mild.

The remarks consist chiefly of details of such circumstances as have fallen under my own observation, and of conclusions drawn from them, and from an attentive consideration of the facts recorded by others.

TABLES

OF THE

Various Species of Periodical Birds observed in the Neighbourhood of Manchester.

THE periodical birds may with propriety be arranged under four distinct heads.

1st. The summer birds, or those species that appear during the spring months and retire in autumn.

2d. The winter birds, or those species that appear during the autumnal months and withdraw in spring.

3d. Those birds that are irregular in the times of their appearance and disappearance.

4th. Birds that are partially periodical, retiring in particular districts only.

The tables contain those species of periodical birds that I have observed in the neighbourhood of Manchester, classed according to the above method; with the periods at which most of them appear and disappear, taken at a mean of eight years' observations, commencing with 1814, and terminating with 1821.

TABLE I.

Periodical Summer Birds.

Birds.	Appear.	Disappear
1 Sand Martin——Hirundo riparia	Aprii 6	Sept. 16
2 Wryneck——Yunx torquilla.....	do.	
3 Willow Wren——Motacilla trochilus	do. 12	do. 12
4 Redstart——Motacilla phœnicurus.....	do. 13	do. 5
5 Wheat-ear——Motacilla œnanthe	do. 14	do. 18
6 Swallow——Hirundo rustica.....	do. 18	Oct. 11
7 Whinchat——Motacilla rubetra.....	do. 20	Sept. 17
8 Black-cap——Motacilla atricapilla	do. 22	do.
9 Martin——Hirundo urbica.....	do. 23	Oct. 13
10 Cuckoo——Cuculus canorus.....	do. 24	June 28
11 Yellow Willow Wren——Motacilla sylvicola	do. 28	Sept. 10
12 Stonechat——Motacilla rubicola	do.	do.
13 Sandpiper——Tringa hypoleucos	do. 29	do. 19
14 Grasshopper Warbler——Motacilla locustella	do. 30	
15 White-throat——Motacilla sylvia.....	May 2	do. 17
16 Swift——Hirundo apus.....	do. 8	Aug. 18
17 Pettychaps——Motacilla hortensis	do. 12	Sept. 11
18 Land Rail——Rallus crex	do. 14	do. 30
19 Flycatcher——Muscicapa grisola	do. 14	do. 13
20 Sedge Warbler——Motacilla salicaria.....	do. 19	
21 Red-backed Shrike——Lanius collurio.....	do.	
22 Goatsucker——Caprimulgus Europæus		do.

TABLE II.

Periodical Winter Birds.

Birds.	Appear.	Disappear
1 Snipe——Scolopax gallinago	Sept. 28	March31
2 Redwing——Turdus iliacus	Oct. 9	do 26
3 Mountain Finch——Fringilla montifringilla ..	do. 18	April 14
4 Woodcock——Scolopax rusticola	do. 26	do. 2
5 Jack Snipe——Scolopax gallinula	do.	
6 Fieldfare——Turdus pilaris...	Nov. 1	March18
7 Water Rail——Rallus aquaticus.....		

TABLE III.

Birds that are irregular in the times of their appearance and disappearance.

Birds.	Appear	Disappear
1 Crossbill——Loxia curvirostra.....	Aug. 5	Nov. 19
2 Siskin——Fringilla spinus	Dec.	
3 Chatterer——Ampelis garrulus		
4 Hoopoe——Upupa epops.....		
5 Great Shrike——Lanius excubitor.....		

TABLE IV.

Birds that are partially periodical.

Birds.	Appear	Disappear
1 Throstle——Turdus musicus....	Feb. 4	Nov. 2
2 Starling——Sturnus vulgaris...	do. 9	Aug.
3 Green Grosbeak——Loxia chloris.....	do. 25	Oct. 23
4 Common Bunting——Emberiza miliaria....	March 3	
5 Pied Wagtail——Motacilla alba.....	do. 11	do. 16
6 Reed Bunting——Emberiza schœniclus	do. 17	Sept.
7 Lesser Redpole——Fringilla linaria.....	April 3	Nov. 5
8 Yellow Wagtail——Motacilla flava	do. 17	Sept. 10
9 Lapwing——Tringa vanellus.....	do.	
10 Merlin——Falco œsalon	Oct.	
11 Grey Wagtail——Motacilla boarula.....		April
12 Ring Ouzel——Turdus torquatus.....	Dec.	

A Table of several remarkable Periodical Birds, eared in the Neighbourhood of Manchester during the last ermometers, exposed to the open air in a shady situation; es, with the difference of the means both general and par any species, exceeds the mean temperature at the time o ver the contrary occurs.

BIRDS.		1817.	Mean Temperature	General Means.
Sand Martin	appeared....	April 3	51°	50.°7
	disappeared.	Sept. 17	64.5	58.8
Difference of means...			+ 13.5	+ 8.1
Willow Wren	appeared....	April 19	43	47.6
	disappeared.	Sept. 12	62.5	60.9
Difference of means...			+ 19.5	+ 13.3
Swallow	appeared....	April 25	42	47.9
	disappeared.	Oct. 9	51.5	51.5
Difference of means...			+ 9.5	+ 3.6
Martin	appeared....	May 6	53	48.8
	disappeared.	Oct. 12	45.5	50.9
Difference of means...			− 7.5	+ 2.1
Cuckoo.....	appeared....	May 9	47.5	48.2
	disappeared.	June 25	72	63
Difference of means...			+ 24.5	+ 14.8
Swift.....	appeared....	May 10	50.5	49.1
	disappeared.	Aug. 11	56	61.5
Difference of means...			+ 5.5	+ 12.4
Redwing.....	disappeared.	April 2	52.5	45.4
	appeared....	Oct. 10	49	51.1
Difference of means...			+ 3.5	− 5.7
Fieldfare	disappeared.	March 25	45	40.5
	appeared....	Oct. 29	41.5	47.4
Difference of means...			+ 3.5	− 6.9

Remarks tending to establish the opinion that the Periodical Birds migrate.

THE gradual increase of temperature in spring, and its decrease in autumn, are circumstances that seem to be so closely connected with the appearance and disappearance of the periodical birds, that they have long been considered as the primary causes of these phenomena. In reflecting on this very generally received opinion, it occurred to me, that I had never met with any attempt to ascertain how nearly the temperature at the time of the appearance of these birds coincides with the temperature at the time of their departure; and as this is a consideration of no slight importance, I resolved, at least in some measure, to supply the deficiency. For this purpose, I took from my journal the dates at which several of the more remarkable species of periodical birds have appeared and disappeared in this neighbourhood during the last five years; and having arranged them in the order of their occurrence, I attached to each the mean temperature for that day, as in the annexed table, *(see table.)*

According to this table, it seems that the temperature is, in general, considerably higher when the sand martin, willow wren,

swallow, and martin withdraw, than it is when they appear; and with regard to the cuckoo and swift, this is uniformly the case in a very remarkable degree: but, as the motions of the periodical birds may be supposed to be influenced by the weekly or monthly, rather than by the daily mean temperature; let us compare the mean temperature of April, the month in which most of the summer birds are first seen, with that of September, the month in which they chiefly retire.

A comparative view of the mean temperature of April and September, from 1817 *to* 1821 *inclusive.*

Years.	1817.	1818.	1819.	1820.	1821.	Gen. means.
April...	46.8	45.1	50.5	50.7	48.5	48.3
Sept. ..	58.9	58.3	57.1	56.1	58.4	57.7
Dif. of means.	+12.1	+13.2	+6.6	+5.4	+9.9	+9.4

Still the temperature at the time of the disappearance of the birds under consideration is found greatly in excess. We will now examine how nearly the mean of October corresponds with that of April.

A comparative view of the mean temperature of April and October, from 1817 *to* 1821 *inclusive.*

Years.	1817.	1818.	1819.	1820.	1821.	Gen. means.
April...	46.8	45.1	50.5	50.7	48.5	48.3
Oct.	46,3	56.5	50.1	47,7	50.5	50,2
Dif. of means.	− .5	+11.4	− .4	−3.0	+2.0	+1.9

A very near approximation is here observable in the temperature of these months, allowing for the unusual warmth of the latter in 1818: yet swallows and martins are almost the only summer birds seen in October, and they generally retire before the termination of the second week; though bats, field-mice, and various species of phalænæ, tipulæ, muscæ, &c., are visible till the close of November; and even through the winter when the weather is open. In the year 1820, long-eared bats (vespertiliones auriti) were observed till nearly the middle of November: and in 1821, they were first noticed on the 23rd of April, the mean temperature for the day being 50°.5, and were seen through November, to the 8th of December, when the mean temperature was 46°; the mean for November being 47°, which is within 1°.5 of that of April for the same year.

Now, if the periodical summer birds, when they withdraw, do not migrate into more genial climates, they must retire to suitable retreats, in which they pass the winter months in a state of torpidity. But where are these suitable retreats to be found? The notion of the submersion of these birds in lakes, ponds, and rivers, is too absurd to merit a moment's consideration, as they are not only specifically lighter than water, but quite unfitted for existence in it by their organization.

Mr. Gough in his remarks on migration, published in the Memoirs of this Society, Vol. II. New Series, from a consideration of the laws that regulate the temperature of the earth at all moderate depths beneath its surface,* clearly establishes the fact, that deep caverns cannot be the winter retreats of the periodical summer birds, as their temperature is not far from the maximum when these birds retire; and is near the minimum about the time that they begin to appear. He then proceeds to observe, (p. 461—2,) that "very few arguments will be now required to demonstrate the impossibility of the analogy which is supposed to connect the

* Those who wish for information on this subject, may consult Saussure's Voyages dans les Alpes. Tome III, chapitre XVIII.

periodical birds of summer, and the sleeping animals of winter. It is sufficient barely to remark, that the former are never found slumbering with the latter, near the surface of the earth, and deep caverns are proved to be unfit for the reception of any creature in the torpid season. Consequently the birds in question desert the temperate zones at the approach of winter, to seek a better climate in lower latitudes." These conclusions, however, will appear to have been formed rather hastily, when we consider what numbers of bats become torpid every winter in this country, and how rarely they are discovered in their dormitories. Might they not have been derived more satisfactorily, from the circumstance of the summer birds being seldom or never found abroad, with the sleeping animals, during the mild weather that we frequently have in winter? Bats, field-mice, &c., usually appear when the mean daily temperature is about 50°; but I am not aware that there is a single instance on record, of any of our periodical warblers, properly so called, having been observed in the cold season, either in a state of active existence, or of torpidity.* A few, indeed,

* Since writing the above, I find that Montagu, in the Supplement to his Ornithological Dictionary, asserts that he has occasionally dis-

are occasionally to be seen at the customary time in spring, even when the weather is frosty, the increments of temperature by no means corresponding with the sun's increasing northern declination, but they generally seem to withdraw again. On the 9th of April, 1821, several sand martins were observed at a sand-pit in the township of Cheetham, but the weather becoming cold and stormy, they quickly disappeared: they were, however, soon after discovered in greatly increased numbers, at a sheltered bend of the river Irwell, in the adjoining township of Broughton. This circumstance proves, that if the weather is severe and boisterous when the summer birds are first seen in spring, they do not retire to their winter retreats, as has been supposed, but merely seek sheltered situations where they can procure a supply of food.

Inquiries into the temperature of the supposed winter retreats of the periodical summer birds, may now be looked upon, it is presumed, as quite superfluous, since it is sufficiently apparent from the preceding tables, that even that of the atmosphere is much higher at the time they disappear than it is

covered the lesser pettychaps (Motacilla hippolais) in the south of Devonshire, in mild winters.

when they appear, the very reverse of what ought to be the case if they become torpid, and of what is actually found to be so, with the sleeping animals of winter: indeed, it seems impossible that any animal should become dormant, in a temperature superior to that which is required to revive it from its lethargic state: it is evident, therefore, that the birds in question must migrate. As there are, however, several other curious facts relating to the periodical birds, which throw great light on the subject of migration, and powerfully tend to confirm this opinion, I shall proceed to examine them.

It is a very surprising circumstance, that several species of periodical summer birds almost constantly return to the same places in the same numbers; and there are sufficient reasons for believing that these birds are generally the same individuals. Four or five pairs of swallows, and about two pairs of redstarts and of flycatchers visit our family residence, in Crumpsall, every spring; and White in his Natural History of Selborne, p. 230, says, "among the many singularities attending those amusing birds the swifts, I am now confirmed in the opinion that we have every year the same number of pairs invariably:" and again, "the number that I con-

stantly find are eight pairs." Now, as these birds usually make their nests in the same situations, this alone, is a strong proof of their identity: great additional weight, however, is given to this proof, by the peculiarity of the situations in which such birds occasionally build. For three successive years, a pair of swallows built in a pig-sty belonging to a relation of mine, their ingress and egress being by a very low entrance: and in Bewick's History of British Birds, Vol. 1. p. 253, it is stated on the authority of Sir John Trevelyan, Bart., that "at Camerton Hall, near Bath, a pair of swallows built their nest on the upper part of the frame of an old picture over the chimney, coming through a broken pane in the window of the room. They came three years successively, and in all probability would have continued to do so if the room had not been put into repair, which prevented their access to it." White, in speaking of the Selborne swifts, (Hist. Sel., p. 186,) says, "they frequent in this village several abject cottages; yet a succession still haunts the same unlikely roofs: a good proof this," he observes, "that the same birds return to the same spots:" and he remarks of the martin, (p. 161,) that, "the birds that return yearly bear no manner

of proportion to the birds that retire;" and this is uniformly the case. Now swallows and martins have frequently two broods in a summer; the first consisting of about five young ones, and the second of three, upon an average; and redstarts, flycatchers, and swifts, have one brood; the two first species usually rearing four or five, and the last two young ones. What then becomes of this increase? If these young birds do not quit the country, why are they not seen in the ensuing spring? These are perplexing questions, questions which the advocates of torpidity will find it impossible to answer: indeed, they involve difficulties which can only be removed by admitting, what is undoubtedly the case, that these birds migrate; and that being deserted by the old ones, and losing all recollection of the places where they were brought up, they are directed in their spring flight by fortuitous circumstances, and are thus diffused over a large portion of the globe.

The highly interesting and important fact, that several species of periodical summer birds moult during the interval that elapses between their departure and re-appearance, if generally known to ornithologists, would, it is reasonable to suppose, have been fre-

quently and strenuously urged, as one of the most conclusive arguments that could be advanced in support of migration: but notices of this nature are extremely rare; as perhaps no part of the animal economy of the feathered tribes, has been so entirely neglected by natural historians, as their moulting. That swallows, swifts, cuckoos, redstarts, and flycatchers, moult during their absence, scarcely admits of a doubt. I have cut feathers out of the wings and tails of swallows, so that I could easily distinguish them when flying; and I find that such feathers are never replaced while these birds remain with us. Great numbers of young swallows retire in autumn, before the exterior feathers of their tails have acquired their full length; yet the tail feathers of those birds that return in spring are always perfect in their growth. To these facts I shall add a few extracts from Mr. Pearson's account of his experiments made for the purpose of preserving swallows alive through the winter, as given in Bewick's British Birds, Vol. 1. p. 250—1, which are decisive as to the moulting of this species. The first year's experiment failed, but the second attempt was completely successful, as Mr. Pearson states, that "the birds throve extremely

well; they sung their song through the winter, and soon after Christmas began to moult, which they got through without any difficulty, and lived three or four years, regularly moulting every year at the usual time. On the renewal of their feathers it appeared that their tails were forked exactly the same as in those birds which return here in the spring, and in every respect their appearance was the same. These birds were exhibited to the Society for promoting Natural History, on the 14th day of February, 1786, at the time they were in a deep moult, during a severe frost, when the snow was on the ground." The account is concluded by Mr. Pearson in the following words. "Jan. 20, 1797.—I have now in my house, No. 21, Great Newport-street, Long Acre, four swallows in moult, in as perfect health as any birds ever appeared to be in when moulting." The plumage of swifts, from exposure to the sun and air, loses that deep soot colour which it always has on their arrival, and becomes gradually paler till they withdraw. This circumstance has not escaped the observation of Mr. White. (See his Hist. Sel., p. 183.) The plumage of young cuckoos, redstarts, and flycatchers, is very different from that of adults. Young cuckoos have the upper parts

marked with various shades of brown, mixed with black, where the old birds are dove-coloured; and the under parts are pale brown, barred with dusky brown, where the old ones are white, barred with black: in short, their appearance is in many respects so totally different from that of their progenitors, that they easily might be, and probably often have been mistaken for a distinct species. Young redstarts and flycatchers have their heads, necks, backs, scapulars, &c., spotted; the former with pale yellow, and the latter with white, which is not the case with old birds; and those marks which so clearly characterize the sexes of redstarts when their plumage is matured, are altogether wanting in young birds. Now, as young cuckoos, redstarts, and flycatchers, do not appear to cast their nest feathers before they retire, they are readily distinguished from old birds while they stay with us: and as birds of these species are never found to retain their first feathers on their return in spring, they must moult in their absence; and it is probable that this may be the case with the periodical summer birds generally:* but it is perfectly ridiculous to suppose that these birds in a state of torpidity, when the animal

* In this attempt to prove that some of the periodical summer birds

functions are nearly suspended, can both throw off their old feathers, and put out new ones; therefore, they must seek those countries which supply a requisite degree of warmth, and a sufficient abundance of food, to enable them to change their feathers. Old cuckoos leave us late in June or early in July, when the temperature is approaching the maximum for the year; and swifts retire about the middle of August, when the temperature though receding from the maximum, is still very high. To what cause, then, shall we attribute the early retreat of these birds? certainly not to a deficiency of food, as young cuckoos are frequently found to remain upwards of a month after the old birds have left; and swifts are occasionally seen, long after the great body of their congeners has withdrawn;* and yet these birds procure

moult during their absence, I have purposely confined my remarks to such species as are well known, and easily observed. The red-backed shrike, whinchat, and some others, with whose habits and economy we are less familiar, might, however, be added to those already enumerated. In my opinion respecting the moulting of the red-backed shrike, I am supported by Montagu; who affirms, "that all the young, when they leave us in the month of September, very much resemble the adult female; and the whole return to us again in about six months, in their full sexual plumage." See the Supplement to his Ornithological Dictionary.

* In the year 1815, I saw a swift in the township of Crumpsall, on the 20th of October; and the same bird was seen again on the 25th; which is more than two months beyond the time at which these birds

plenty of nourishment. Is it not, rather, occasioned by a propensity to moult, and the want of a suitable degree of warmth to enable them to change their feathers? Our domestic fowls begin to moult in July, the hottest month in this latitude, and birds in a state of nature, usually moult when they have done breeding: if, therefore, the temperature of July is not sufficiently high to promote the moulting of the periodical summer birds; cuckoos, as they leave the care of their progeny to strangers, and, of course, are at liberty when they have deposited their eggs, should be the first birds that withdraw: swifts also, having only two young ones to rear, should be the next birds that retire: the periodical warblers, and those birds that have five or six young ones, ought to quit in the next place: and swallows and martins,

usually depart, and nearly a fortnight after the last swallows and martins had left us: and in the year 1818, I saw one at Chester, on the 18th, 19th, and 20th of October. I had opportunities of observing both these birds attentively for a length of time, and I remarked that they always seemed to be in the active pursuit of their prey. White, in his Hist. Sel. p. 284, mentions an instance of a swift being induced by attachment to its young, to remain till the 27th of August; and though deserted by its mate early in the month, it reared a second brood (the first having been destroyed) without assistance: a convincing proof, that however disagreeable it may be for swifts to prolong their stay, they are not compelled to quit so early as they do, by any difficulty in obtaining food.

which have two broods in a season, ought to be the last that depart: and this is always found to be the case: so that whether the departure of these birds be influenced by a propensity to moult or not, it seems to be regulated, in a great measure, by the cessation of their parental cares, and not by temperature solely.

It will be difficult to produce any direct evidence of the migration of the periodical summer birds, until their winter retreats are well ascertained;* but from what has been already advanced respecting these birds, it will be seen, that this fact may be most satisfactorily proved indirectly, by a process of reasoning somewhat analogous to that adopted by geometricians in investigating such propositions as do not admit of a direct solution; namely, by shewing that the contrary supposition involves an absurdity. It is absurd

* Adanson asserts that European swallows pass the winter in Senegal, but does not particularize the species: (see his Histoire Naturelle du Sénégal, p. 67:) and it appears probable, from the observations of Mr. White's brother, (the Rev. J. White,) who resided at Gibraltar; (Hist. Sel., p. 87, 88, 139;) that many of our periodical summer birds may winter in Africa. The length and difficulty of such a journey, are the chief objections that have been urged against this opinion; but they will cease to be looked upon as serious obstacles, when we reflect, that these birds may pass hence to the equator, without crossing any great extent of sea; and, that as they are continually advancing into better climates, they are enabled to travel leisurely, there being no necessity for extraordinary haste.

to suppose that the summer birds can become torpid with an increased or an increasing temperature: or that they can change their feathers in such a state, when the organs of secretion are known barely to perform their several offices: or that under such circumstances, scarcely more than one fourth of those birds that withdraw in autumn, should re-appear in spring, though the same birds almost constantly return to the same haunts: these suppositions, I repeat, are manifestly absurd, therefore the summer birds must migrate.

Writers in treating of the periodical birds, have confined their observations, almost exclusively, to the various species of swallow; neglecting, in a great measure, the short-winged summer birds, which seem to be the least qualified for migration; and the periodical winter birds, which furnish some of the strongest arguments in support of it.

If the periodical winter birds, do not leave this country in spring, they must stay with us the year through: yet it is in the highest degree improbable, that woodcocks, jack snipes, mountain finches, and the numerous flocks of redwings and fieldfares that are seen in winter, should remain here during the summer months, and yet elude the observation of ornithologists. The redwing is ge-

nerally admitted to be a bird of song;* and as most of the thrush tribe sing more or less, it is very probable that the fieldfare is a singing bird also; yet we know nothing of their songs, or summer notes, but are merely acquainted with their calls, which are heard in winter only: and I believe there is not one well authenticated instance of the nests of these birds having been found in England.

According to Linnæus, redwings and fieldfares breed in Sweden. In his Fauna Suecica he says of the fieldfare, that "maximis in arboribus nidificat:" and of the redwing, that "nidificat in mediis arbusculis, sive sepibus: ova sex cæruleo-viridia maculis nigris variis:" but it is plain that they must leave that country in winter, as with us, redwings are among the first birds that suffer in inclement weather; and both redwings and fieldfares withdraw from our northern counties, and great numbers of them even quit the kingdom entirely, during long and severe frosts, especially if they are accompanied with snow.†

* Linnæus says, that "its lofty and varied notes rival those of the Nightingale." See his Lachesis Lapponica, translated by J. E. Smith, M. D. &c. Vol. 1. p. 6.

† In the severe winter of 1813–14, the northern counties of England were nearly deserted by redwings and fieldfares; and I have been informed, that at this period they were far from being plentiful in the southern counties.

Scopoli, in his Annus Primus, says of the woodcock, that "nupta ad nos venit circa æquinoctium vernale. Nidificat in paludibus alpinis. Ova ponit 3—5. Migrat post æquinoctium autumnale. Fugit brumam et acre gelu." and of the fieldfare, that "migrat Novembri mense." Thus it appears that woodcocks breed in the Tyrol, which they quit about the latter end of September; and that fieldfares leave the same country in November: and it is well known that woodcocks desert the more northern countries of Europe at the commencement of winter. Here, then, we have positive evidence of the migration of the redwing, fieldfare, and woodcock, some both of their summer and winter haunts being known. That redwings and fieldfares migrate, those who are acquainted with their calls may be easily convinced; as the faint scream of the former, and the chattering note of the latter, may be heard frequently repeated through the nights of October and November, as their numerous flights pass over head; and as this is the time at which these birds visit us, and as their calls cease to be heard at night soon after this period, they must then be on their passage from some other country to this; or to countries still farther south. This circumstance also

establishes the fact, that some species of periodical birds perform their migrations in the night; and it is probable that this is the case with most of them; as I have frequently looked through the woods and plantations in Crumpsall with great care in April, the month in which most of the summer birds appear, without perceiving a single individual of any of the migratory tribes; yet early in the morning of the day following that on which the search was made, I have been surprised to hear the notes of the redstart and willow wren, and to find that the latter species had arrived in considerable numbers.

Having endeavoured, in the foregoing remarks, to prove the migration of the periodical summer and winter birds; I shall here briefly observe, that our irregular visitors also must migrate; as it is equally impossible that they should lie torpid during a period of several years, or that they should escape the notice of observers for so great a length of time. Thus, the migration of every description of periodical birds, whose disappearance it has been difficult to account for, seems to be established; and I shall conclude this paper with observing, that if swallows and martins do become torpid under some circumstances, they are probably en-

dowed with this propensity, for the preservation of those individuals that are prevented from joining their species in their autumnal flight.

REMARKS

ON

THE SITE OF TROY,

AND

ON THE TROJAN PLAIN.

Founded on Personal Observation.

BY ROBERT HYDE GREG, Esq.

(Read before the Society, Feb. 22. 1822.)

" High barrows, without marble or a name,
" A vast, unfilled, and mountain-skirted plain,
" And Ida in the distance still the same,
" And old Scamander, if 'tis he, remain;
" The situation seems still formed for fame,
" A hundred thousand men might fight again
" With ease; but where I sought for Ilion's walls,
" The quiet sheep feeds, and the Tortoise crawls.

Don Juan, Canto IV.

IN the present advanced state of classical and scientific attainments, it must be reserved for men of genius or of leisure to extend the bounds of knowledge by new discoveries. Those who are engaged in the active pursuits of life can aspire to little, but to condense the voluminous productions of others, or to place their arguments in a clearer and more forcible point of view.

It is but little more which I propose to attempt on the present occasion.

The site of ancient Troy has been an object of research amongst antiquarians for above 2,000 years, and though much light has been thrown on the subject in later times, by a more correct knowledge of the topography of the Troad, and more critical study of the Iliad, it is a question still disputed as warmly as ever, and apparently with as little chance of being ever decided.

Amidst so much conflicting testimony, and so many learned doubts, where it is difficult to arrive at a conclusion satisfactory to our own mind, it would be a vain hope to impress conviction on that of others. We trust, however, that after a candid review of the arguments, and an attentive application of the text of the Iliad to the topography of the Troad, we shall not be called presumptuous for asserting, that there is one spot on the Trojan plain, which, above all others, presents a plausible title to being the site of that celebrated city.

The number of learned men, who have devoted their time and talent to the decision of this question, proves it to be one replete with interest; nor can it ever be regarded as devoid of importance, since whatever places

in a stronger light the accuracy of Homer, adds credibility to the early history of Greece, which has little other foundation than the facts recorded in his poems.

It may perhaps appear paradoxical to assert, that, previous to our enquiry, it is not necessary to prove, nor even to believe, that a war between Greece and Troy ever took place, nor even that such a city as Troy ever existed. Supposing the Iliad to be a mere fiction of the poet, yet he has so interwoven the action with some real scenery, that our enquiry is the same, whether for the site of a genuine Troy, or for the spot selected by him as the site of his imaginary city. The interest, however, with which we should pursue the enquiry, and our satisfaction at a successful result, must necessarily be much more lively, when we believe, than when we doubt, the actual existence of Troy, and, had time permitted, we would have entered at some length on this interesting question. But in every investigation some things must be taken for granted, and were we not to advance till the doubts of every sceptic were satisfied, we must begin by proving the existence of a material world. After a few cursory remarks, therefore, we will proceed without delay to the plain of Troy.

Existence of Troy and of Homer.

To those who doubt the truth of the received account of Homer and his writings, and who imagine that the Iliad and Odyssey are mere compilations of different poems on the same subject, written by many poets, or the disjointed rhapsodies of an individual, collected and arranged in after times, we can oppose, besides the total want of evidence for their supposition, the perfect uniformity of plan and style in the story and writing, and the matchless consistency preserved throughout in the characters of all his heroes.

Every argument which can be brought against the Trojan war and the existence of Troy, has been adduced by Mr. Bryant in his ingenious "Dissertation on the Trojan War." These would, perhaps, have had more weight with his readers, had he not conducted them to the strange conclusion, that a small place of the name of Troy existed in Egypt, and that some verses, found by Homer in an Egyptian temple, relative to a war which took place there, furnished him with the basis of the Iliad. But here we must again object the want of evidence to warrant so unexpected a conclusion. His

objections to the history contained in the Iliad, Mr. Bryant grounds, almost wholly, on the improbability of the facts therein related:—for example, the combination of so many independent chiefs to avenge the injury of one;—the great size of the fleets and armies;—the long duration of the siege, and there being no remains of the ancient city.

It would, perhaps, be a sufficient and reasonable answer to objections of this nature, if we replied, that as (1) Homer lived between two or three centuries after the events which he describes, the tradition from which he wrote might be as inaccurate and exaggerated, as traditions usually are; or that, as a poet, he indulged his fancy, magnified, and embellished. Homer, himself, seems not to demand implicit belief in all that he relates, for he invokes the aid of the muses not only to enable him to sing well, but to supply him with facts, of which he declares his ignorance: For he says, (2)

(1) Homer flourished about A. C. 907. Troy was taken A. C. 1184, or according to the Arundelian Marbles, A. C. 1209. *Tytler.* He was most probably a native of the Isle of Chios, or of some place on the neighbouring coast.

(2) The references are all to Cowper's translation of the Iliad, which has the double advantage of being familiar to most readers, and of being at the same time a most faithful, and indeed a literal, translation of Homer.

is seldom that any point in the course of this discussion turns on

"Ye are heavenly, and beheld
"A scene, whereof the faint report alone
"Hath reached our ears, remote and ill-informed." *Iliad. II.* 250.

This, or some similar answer, must naturally suggest itself to every person, to whom Mr. Bryant's objections are proposed, and would, we should have imagined, be deemed satisfactory;—we find, however, that they have produced a considerable impression, and will therefore attend for a moment to what may be urged in reply.

As to the extraordinary combination of so many chiefs in such a cause, it is not without a perfect parallel in the annals of our own country; for, as Mitford has justly remarked, (3) the conquest of Ireland by Henry II, was the immediate consequence of events, in every attendant circumstance exactly similar to those which ultimately caused the destruction of Troy.

As to the number of the ships, the vessels were probably small, and we know that na-

the exact or peculiar meaning of a single word or phrase, where it does, I have consulted friends well versed in the original, and compared their translations with Clarke's Latin one. But the meaning of a particular word is so seldom of importance, that in most cases, Pope's version, free as it is, would be a sufficient guide.

(3) Mitford's "History of Greece," Vol. I. page 63.

tions in a semi-barbarous state, can send forth larger armies than when more civilized. But numbers are easily exaggerated, and most probably are so in the Iliad; and this no more invalidates the truth of the account, than the contradictory statements and overgrown calculations of the forces under Darius and Xerxes make us doubt the reality of their invasions.

As to the duration of the siege, it was, perhaps, the acquisition of plunder, as much as the quarrel of Menelaus, which detained the Greeks so long from home. Achilles says,

"I have destroyed
"Twelve cities with my fleet, and twelve, save one,
"On foot contending on the plains of Troy.

They were, therefore, engaged in piratical excursions, which probably carried them to a distance, and detained them long. If the duration of the siege is an improbable circumstance in the account, the history is, however, perfectly consistent with itself, and to a degree which strongly confirms its truth. The Greeks we find had courts of justice, forum, and altars, established in the fleet, from which it is fair to conclude, that they had been stationary for some time. Agamemnon,

alluding to their protracted stay, remarks,

"Our ships are rotted and our cordage marred." *Iliad II.* 152.

And we may infer that the Trojans had for some years been unable to cultivate their land, from the complaint of Hector, that the immense treasures of Priam had been

"Marketed, and Phrygia hath a part
"Obtained, and part Mæonia's lovely land.
Iliad XVIII. 354.

Whilst the Greeks continued to ravage the country, the Trojans were necessarily compelled to purchase corn for themselves and allies. It is generally supposed that the Greeks had no communication with home, during their ten years' absence at the Trojan war, and this is urged by some as a further objection to Homer's history. It is certainly singular that no direct mention is made of any communication with Greece, but we must remember, that the action of the Iliad occupies only a few days, and possibly no opportunity, or rather necessity, arose for describing what intercourse, if any, had taken place. From the address of Achilles toPatroclus however, at the commencement of the XVI book, we may reasonably infer that the Greeks did maintain some connexion with home.

"Say bringst thou tidings? and concern they most
"My people, or myself? Hast thou alone
"Heard ought from Phthia? Still, as they affirm,
"Menœtius, son of Actor, lives, and still
"Peleus Æacides.

Troy remained in safety for nine years, because the Trojans kept within their walls: a sufficient reason, and the one assigned by Homer. The Greeks had not the art of storming fortified cities, and never made an attempt to do it; and we find that 800 years after the Trojan war, the Romans were detained for 10 years before the walls of Veii.(4)

Mr. Bryant again objects that there are no remains of Troy. But, supposing this to be true, we would ask, what can he reasonably expect to survive of a city, sacked and burnt 3,000 years ago?—of a city too, known only as the subject of a poem, when the ruins of the mighty Babylon can scarcely be distinguished from the plain on which it stood!

But Scepticism has no limit: nothing has ceased to be, the existence of which may not be disputed, and, perhaps, nothing exists, which will not some day be called in question.

(4) Veii was taken A. C. 391.

"I have stood upon Achilles' tomb,
"And heard Troy doubted: Time will doubt
of Rome. *Don Juan, Canto IV.*

In the absence of all direct evidence against the existence of Troy and the Trojan war, we will repose with confidence on the universal belief of those ages which approached nearest to the time, when the events are stated to have occurred, and, above all, on the credit given to Homer by the acute historians of Greece. Without further delay, therefore, let us proceed to the part of the subject more immediately before us.

Troy and the Trojan Plain according to Homer.

HOMER sung to those acquainted with the places where the action of his poems is laid; (5) and we find no detailed account of the scenery of the Iliad. Our knowledge of it arises simply from incidental descriptions

(5) It is worthy of remark that Homer when speaking of Troy or its neighbourhood, rarely enters into any description of places or objects, but merely alludes to them as to what was equally familiar to himself and hearers. In referring to places in Greece, he frequently describes them as if addressing those to whom they were unknown.

of the course of an army, or the action of his heroes.

That Troy, indeed, stood in the neighbourhood of Ida and the Hellespont, we learn from almost every page of the Iliad, but the passages which determine the particular plain, the scene of his battles, are neither numerous, nor minute; yet fortunately for our investigation, there is only one plain in the whole district of Ida to which they can refer.

In the thirteenth book of the Iliad, we read that Neptune, seated on the heights of Samothrace,

"Surveyed
"With wonder thence the tumult of the field;
"For thence appeared all Ida, thence the towers
"Of lofty Ilium, and the fleet of Greece.

Iliad XIII. 16.

Now as there is only *one* plain which opens on the sea in the direction of Ida, and Samothrace commands a full view of it in its whole extent, we may fairly conclude this to be the plain of Troy. That it is the true scene of the Iliad we may further infer from the following circumstances.

It is bounded towards the sea by two remarkable promontories, those of Sigeum and Rhœteum, which, though not named by

Homer, are frequently alluded to by him, as terminating the two extremes of the bay where the Grecian fleet was drawn up.

Between these promontories the only river of any magnitude in the district of the Troad, discharges itself into the Hellespont; and in its modern name of *Mender* we recognize its ancient one of *Scamander*. The Greek inscriptions found in many parts of this plain, and of which the following is a specimen, (6) "The Ilieans to their country's God Æneas," the evidence of history, and the Homeric names which are still attached to the Tumuli, attest the belief of the ancients that this was the plain of Troy. It was here that Xerxes sacrificed a thousand oxen to Ilean Minerva; it was here that Alexander believed that he had found the tomb of Achilles, and it is hither only that modern travellers direct their steps in looking for the site of Troy.

Homer describes the Trojan plain as traversed by two rivers, the Scamander or Xanthus, and the Simois, which, forming a junction at some distance from the shore, discharged their united waters into the Hellespont. Of the Simois so little is said, that we may conclude it was an insignificant stream; but the Scamander is described as

(6) See Clarke's Travels in Asia Minor

rising in Mount Ida, as being a powerful river, crossed at regular fords, and is always denominated the "swift," "dizzy," "whirling," "vortiginous," Scamander. The public road between Troy and the Grecian camp crossed the Scamander, which is therefore generally admitted to have flowed between these places: it should, however, be noticed, that the armies frequently traverse the plain from the city to the fleet, without any allusion being made to the passage of the river.

Homer makes very particular mention of two springs, one warm, the other cold, rising under the walls of Troy, and which he calls, "Two Fountains of the Scamander," from this circumstance some writers, and amongst them Pope and Chevalier, (7) whose theory we shall presently have to discuss, have imagined that this river actually took its rise near the city.

The city was at a very considerable distance from the sea, as we learn from many passages in the Iliad. If built on the plain, (8) as some authors have maintained, the con-

(7) "Voyage de la Troade."

(8) The belief that Troy stood on level ground, or at least on a gentle slope within the plain, appears to have no other foundation than the expression of Æneas, "Ilium had not yet been reared in the plain." But this observation might mean nothing more than that the hill on which the city was built rose in or from the plain.

stant epithet of "*Wind-swept Ilium*," would be inapplicable. Æneas would not have addressed Hector in the words,

"Shame is our portion if we climb again
"The heights of Ilium:" *Iliad XVII.* 393.

nor would the poet have said of Priam,

"But when from Ilium's gate into the plain
"He had descended," &c. *Iliad XXIV.* 411.

We should conclude therefore that Troy stood, not in the plain, but on a hill, which sloped down to the plain in the direction of the sea.

The Pergama, or lofty citadel of Troy, occupied some rocky heights at the back of the city, which lay between the Pergama and Scean Gate. The Scean Gate was the one nearest the plain: from it the army always sallied forth to battle, and through it they retreated when pursued by the victorious Greeks.

Such then is a brief sketch of Troy and the Trojan plain, as collected from the details of the Iliad. But it is necessary to our subsequent investigation, to make a more minute enquiry into the nature and extent of the Grecian camp, the stations occupied in it by the principal heroes, the extent of the ramparts which defended the Grecian camp, and the situation of the Throsmos, or rising ground where the

Trojans encamped for the night before their attack on the Grecian lines, and, again, after the death of Patroclus.

The Grecian Camp.

THE camp, or fleet, for it was the same thing, and is called indifferently by either name, covered the whole extent of the bay between two promontories, which, by almost universal consent, are admitted to be those now bearing the names of Rhœteum and Sigeum. The ships were drawn up in a double or triple line.

"Since, spacious though it were, the shore alone
"That fleet sufficed not, incommoding much
"The people; wherefore, they had ranged the ships,
"Line above line ascending, and the bay
"Between both promontories all was filled.

Iliad XIV. 39.

The distance between the two promontories of Rhœteum and Sigeum is about two miles, and Homer has been condemned for making his fleet extend in a triple line such an incredible distance.

But whether he has exaggerated, or not, the

size of his fleet, let us enquire whether he is not here, as in other statements, perfectly consistent; if he is, we again contend that it is an argument for the truth of his account. The number of ships enumerated in the list given by Homer amounts to 1186. The large ones are calculated to have contained 120 men, and the small ones fifty, that is, on an average, 85 men to each vessel. (9) For the breadth of a ship, built as they were in former times, and adapted for conveying 85 men with provisions and warlike stores, we cannot suppose it too much to allow 18 feet; and for the breadth of the passages between them 8 feet more; for though Ajax is represented as leaping from ship to ship, which indeed he might do on our supposition, yet the room occupied by the ladders, added to that necessary for passage, must have been considerable. This estimate gives us 26 feet for each ship with its passage, which, multiplied by 1186, gives for the space required for the fleet, if ranged in a single line, 30,836 feet, or if in a triple line, 10,277 feet; that is, about 2 miles, the actual distance between the two promontories stated by Homer to have been covered by the fleet.

(9) See Rennell's "Observations on the topography of the plain of Troy," page 80, in the notes, containing a translation from Thucydides, and his own remarks.

In this calculation we have made no allowance for the width of the Scamander, which, with the marshes on its banks, together perhaps five to six hundred feet, should be deducted; nor for the wider passages for the chariots; nor for the tents, which were numerous, and mingled with the ships; nor for the space occupied by the forum, altars, and courts of justice. Were a fair allowance made for all these circumstances, we have little doubt that the number of ships enumerated by Homer would, even in a quadruple line, have covered the whole bay between the Sigean and Rhœtean promontories.

Station of the Heroes in the Camp.

From the transactions related in the eighth, tenth, and twelfth books of the Iliad, we may collect with considerable accuracy in what part of the fleet the principal heroes were stationed. That the ships of Achilles were at one extremity, and those of Ajax at the other, and that Ulysses occupied the centre, we find clearly stated.

"Agamemnon
"High on Ulysses' towering galley stood,

"The centre ship conspicuous: thence his voice
"Might reach the most remote of all the line,
"At each extreme, where Ajax and the son
"Of Peleus, fearless of surprise, and strong
"In conscious valour, flanked the tented field.

Iliad VIII. 252.

From circumstances stated elsewhere it appears equally certain, that the flank occupied by Achilles was the Grecian right, or the side next Sigeum; that by Ajax, the left flank, next Rhœteum.

The station of Nestor is a point of some importance, as we shall see presently. It was not very far from that of Ulysses, (X. 163.) but must have lain more on the side of Rhœteum than Sigeum, for we read (X. 978) that Patroclus on his way to Achilles at Sigeum, in returning from the tent of Nestor, has to pass through the forum and by the ships of Ulysses which occupied the centre. The stations of Agamemnon and Menelaus (X. 30 to 376) appear to have been near each other, and near that of Nestor, and, as might be expected, not far from the centre of the fleet, and the vicinity of the forum.

The station of Idomeneus was near that of Ajax,

——"at the camp's extremest bounds."

Where the other chieftains were stationed is alike difficult to learn and immaterial to ascertain.

Grecian Ramparts.

A complete account of the construction of these ramparts is given in the seventh book of the Iliad. They extended in length from one promontory to the other, but our enquiry need be directed only to the breadth of the space included between them and the sea.

It is obvious that if the ramparts were built close to the sterns of the outermost line of vessels, as might be supposed from the account given of them in book XIV, 34, this space must have been very limited, and the ramparts near the sea.

But so far from the details of the Iliad favouring this statement, they are entirely subversive of it, and lead us to the conclusion, that the distance from the ships to the ramparts was considerable, and consequently that these extended far up the plain.

When the Greeks first fortified their camp, they must, of course, have anticipated the probability of the Trojans becoming masters of the open field, and, consequently, of all their cattle, if allowed to range in their accustomed pastures. Their numerous flocks and herds must therefore have been included within the ramparts. These alone, numerous as they must have been for the supply, although a temporary one, of 100,000 men, would necessarily occupy much room; but if to this we add the pasturage requisite for their support, we must allot a much larger portion of the plain to the Grecian camp than what the triple line of ships actually occupied.

We find, moreover, (Book XIII, 958; XIV. 27 to 460: XV. 455 to 671, and XVI. 358 to 430) that there was space sufficient between the ships and the ramparts to allow both armies, amounting to about 100,000 men, to draw up in battle array, to manœuvre, advance, and retreat, and to attack with chariots, and in phalanxes mutually opposed, and consequently occupying a great space from the rear of one to that of the other. In book XII, 327, the Greeks, when defending the ramparts from the assault of Hector, are exhorted by Ajax not to *turn and fly to the ships*. In book XIV, 511, when Hector is

wounded within the ramparts, he is borne away "*behind the tumult of the fight,*" that is, through the Trojan army, for he was fighting in advance, to the place where he had left his chariot, which, as we read before, was at the brink of the fosse. In book XVI, Patroclus drives the Trojans from the ships; they continue *fighting in retreat till they reach the ramparts,* where they break into a tumultuous flight.

We can scarcely, therefore, avoid the conclusion, that the distance from the upper line of ships to the ramparts must have been very considerable, and to allow for this and the triple line of vessels, the space of half a mile cannot be deemed extravagant.

It may be observed, from the nature of the ground, that the length of the ramparts, and consequent labour and time necessary for their erection, would be nearly the same, whether the space included within them were 100 yards wide or 1000 yards. There was no motive therefore for straitening themselves in point of room.

The Throsmos.

THE Throsmos was a hill or rising ground, in front of the Grecian camp, on which the Trojans encamped for the night after the second and third battles.

Rennell supposes the Throsmos to be merely a rise in the beach, such as is found on the sea shore in a flat country;(10) but besides that no such rise exists on the Trojan plain, the distance of the Throsmos from the Greek camp, as we collect from the Iliad, is much too great for Rennell's supposition, and had any such rise existed, it would have been included within the ramparts.

Sir W. Gell supposes the heights behind Sigeum to be the Throsmos, but even these are too near the Grecian camp, and a decisive objection to this notion is, that the Throsmos indubitably lay on the Grecian left, whilst Sigeum lies on the right. An attentive perusal of the tenth book will convince the most prejudiced person of this fact, and it is not an unimportant one.(11)

(10) " Observations, &c." page 99.

(11) Agamemnon, Nestor, and Ulysses, whose quarters lay near the centre of the fleet, send some of those who are to be present at the council, to rouse Ajax and Idomeneus, whose ships were at *Rhœteum*, desiring those chiefs to remain at their station till the rest arrive at the

We have already shown that the distance from the sea to the ramparts was considerable, not less, probably, than half a mile, and if we carefully examine what passed between the Trojan army on the Throsmos, and the Grecian in its camp, on the night after the second battle, we shall find that another half mile is barely sufficient to allot for the distance from the ramparts to the Throsmos.

In book thirteenth, 586 and 600 we read that the Trojans retreating from the ramparts to the *Throsmos*, to encamp there for the night, *left a guard to watch lest the Greeks should escape secretly*, or should by stratagem attempt to reach the city, and surprise it in the absence of its army:—precautions altogether needless, had the Throsmos, where the main body was encamped, been nearer than half a mile to the Grecian ramparts. The circumstance of the Grecian council being held (X. 212.) during the same night, in an open space *without the ramparts* also shows that the Trojan army must have been at a considerable distance.

same spot. When all are assembled, they immediately go forth at the gate nearest the quarters of Ajax. Had the Throsmos lain either facing the centre or right of the fleet, the chiefs would have gone out at some of the other gates, of which there were several.

Again, Ulysses and Diomed (X. 344) quit the spot where the council was held, and proceed towards the Trojan camp to learn what is passing there.

They had continued their course for some time, when they encounter Dolon, who, already,

"The throng of Trojan steeds and warriors past,"

is proceeding at a brisk pace *towards the fleet* on a similar mission. The two Greeks and Dolon are moving in opposite directions, and, from the description given us by Homer, they could not have traversed each a less space than a quarter of a mile; or, in other words, the distance from the ramparts to the Throsmos was fully half a mile. If then the double supposition be correct, that half a mile intervened between the sea and ramparts, and again half a mile between these and the Throsmos, and the Throsmos lay on the Grecian left, we shall on referring to our map (12) observe, that the hill of *New*

(12) In our map we have copied pretty closely from Rennell's. We have not attempted to trace what we suppose the ancient course of the Scamander, or other rivers. Though the best map, Rennell's is nevertheless very inaccurate, and whilst it gives a good general idea of the form and features of the plain, the outline of the hills, their comparative height, and the course of the rivers, are far too inaccurate to support any argument founded on exact distances, or minute localities.

Ilium, is the *first* and *only* rising ground in that direction, and that it stands at the distance of about a mile from what must have been the line of coast at the time of the Trojan war: (13) and we feel not the slightest doubt but that this hill is the Throsmos of Homer.

The Trojan Plain at the present day.

On this plain we now discover four rivers, if, indeed, three of them deserve the name. (14) The first is the Bournabashi stream,

(13) Rennell, to whom all who interest themselves on this subject are deeply indebted for the light he has thrown on the ancient and modern topography of the Troad, has in his "Observations, &c." page 69 to 75, shown with great ingenuity and research, that the sea, at the time of the Trojan war, approached within 4-5ths of an English mile of New Ilium, and that the coast described a curve line, bending inland from Rhœteum to Sigeum.

Now, surely, after deducting from 4-5ths of a mile, the space which the most moderate calculator must allow for the triple line of ships and the ramparts, *what remains* is not a great distance to intervene between the camps of two formidable hostile armies. A less distance would not have afforded safety for the Grecian council, held without the ramparts; would not have caused a necessity for leaving a Trojan guard; nor allowed the double expedition of the two Grecian chiefs on one side, and of Dolon on the other.

(14) There are also some small torrents in different parts of the plain, but which are always dry in summer, and too insignificant to require notice.

taking its rise from two springs near the village of the same name: this, though now diverted from its course, once joined the Mender.

The second is the Thymbrec, or Dumbrick, which, rising in some hills to the east of the plain, terminates its course in the marsh, between the Rhœtean and Sigean promontories. Homer makes no mention of this river, though he does of a valley called Thymbra; and, from the similiarity of name and agreement of situation, most writers think that the course of the Thymbrec is through the valley of ancient Thymbra, and we agree in this opinion. The third is the Kimair, or Shimar, a small mountain-torrent, joining the Mender in the middle of the plain. The same reasons which are adduced for the connexion of the Thymbrec and Thymbra will plead with equal force for the Shimar being the Simois of Homer; but, as it is not of first rate importance to ascertain the identity of either, we will pass on without attempting further proof, which might easily be produced.

The fourth is the Mender, a large and rapid river, which rising in Gargarus, the highest summit of Ida, at a distance of 30 miles from the Trojan plain, discharges its waters into the Hellespont under the promontory of Sigeum.

The plain is about four miles broad in its widest part, but narrows towards the sea, where it is confined between the Sigean and Rhœtean promontories to a breadth little exceeding two miles. It is at present about 7½ miles long, but the shore, since the time of Homer, has gained considerably on the sea, and the bay between the two promontories has been filled up, or converted into a marsh, by the addition of alluvial matter from the Mender and Thymbrec. (15)

The Scamander.

THE river, formed by the junction of the Mender and Bournabashi, has universally been considered as the Scamander of Homer. But to which of these two streams before their junction, this title properly belongs, is a point which has been much disputed; for whilst the most ancient and most recent writers believe the Mender to be the Scamander, Chevalier and his followers, among whom rank Sir W. Gell and Mr. Morritt, maintain the Mender to be the Simois, and the Bournabashi the Scamander.

This opinion is now so nearly exploded, it

(15) See Rennell's Observations, &c., page 69 to 75.

is perhaps unnecessary to reply to it at length: its fall has involved in a common ruin the whole theory of Chevalier which rested upon it. We may content ourselves with observing, that, besides the improbable circumstance of a feeble stream like that of Bournabashi giving its name to such a river as the Mender, the character of both rivers on this supposition, more particularly of the latter, is totally irreconcilable with Homer's description of them. The appellation of dizzy, whirling, swift, and vortiginous, beautifully descriptive, and admirably appropriate, when applied to the Mender, cannot, without the grossest violation of language, be referred to the small, clear, sluggish, stream of Bournabashi, short in its course, and, from the nature of its origin, (16) incapable of being flooded. Besides, Homer states distinctly and repeatedly that it rose in Mount Ida, and we cannot admit Chevalier's solution of the difficulty, that the hill of Bournabashi is a branch of that mountain.

This confusion of the rivers evidently arose from Chevalier's belief, that the springs near Troy, described in the twenty-second book of the Iliad, were actually those from which the

(16) It rises in two warm springs deeply seated, and consequently liable to little or no alteration in the quantity of water they throw up.

Scamander derived its origin. This interpretation is not borne out by Homer, who describes them simply as *two fountains*, not *the two sources*, of the Scamander; intending, perhaps, nothing more, than two springs which supplied, or feeders of that river, which in fact they are. On this supposition, therefore, the springs of Bournabashi may be the two fountains of the Scamander described by Homer, and yet the Bournabashi stream not be the Scamander.

The accounts of the size of the Mender seem to differ, according to the theories of those who describe it, and Chevalier, who is anxious to make it as small as possible, talks of crossing it dry-shod. Clarke and Gell, however, give us the measured width of it, in the lower part of its course, as from 3 to 400 feet; and in the higher part of its course, where I repeatedly crossed it in the month of June, after a long series of dry weather, I found it wider than the Mersey above Warrington, and half as wide as the Thames at Richmond Bridge, with a considerable body of water, and flowing with great velocity. At all events Homer's Scamander was not a brook to be crossed dry-shod, for he gives the following description of it before its indignant waters rose to overwhelm Achilles.

"But when they came at length where Xanthus winds
"His stream vortiginous, from Jove derived;
"There scattering the divided host, he drove.
"Part through the plain to Troy. Other part
"Rushed down the sides of Xanthus: headlong plunged
"With dashing sound into the dizzy stream,
"They struggling shrieked, in silver eddies whirled."

Iliad. XXI. at the beginning.

That any one, who has visited the plain of Troy, should maintain that such a description is more applicable to the Bournabashi stream than to the Mender, is perfectly unaccountable. (17)

Ancient Course of the Scamander.

It is of little consequence to learn what was the course of the Scamander at the time of the Trojan war in the upper part of the

(17) Chevalier and Mr. Morritt endeavour at considerable length to make Homer's descriptions of the Scamander applicable to the Bournabashi stream, and also to make the Bournabashi stream agreeable to Homer's description of the Scamander, but, in this instance at least, they have failed in making "the worse appear the better reason," and the weakness of their argument is suited to the badness of their cause.

plain, but of the *very greatest* to ascertain correctly at what point it discharged its waters into the Hellespont. This, from the nature of the country, must have taken place somewhere between the Rhœtean and Sigean promonteries, and that it did not flow through the camp of the Greeks we may assert with confidence; for besides the extreme inconvenience and risk of having a river from 300 to 400 feet wide traversing the camp, it must have been frequently alluded to by Homer, and mentioned more particularly in the battle when the Grecian lines were stormed. We may, therefore, without hesitation conclude, that it flowed into the Hellespont, close under either the Rhœtean or Sigean promontories.

As Troy and the Grecian fleet stood on opposite banks of the Scamander, if this river discharged itself at the Sigean promontory, Troy must have stood on the *western bank*, if at the Rhœtean, on the *eastern*. Now, as in the present day the Scamander discharges its waters at Sigeum, and as Strabo(18) informs us that in *his* time, near two thousand years ago, it discharged them "near or towards Sigeum," (19) it would not be very unreasonable to conclude, in the absence of

(18) Strabo flourished in the reign of Tiberius, and died about A.D. 25.

(19) "The rivers Scamander and Simois, the latter by directing its course

decisively contradictory testimony, that a thousand years before the age of Strabo, that is, during the Trojan war, it flowed into the Hellespont at the same place. But as all writers, we believe, on this subject, whether they imagine the Bournabashi, or the Mender to be the Scamander, maintain, or rather seem to have taken it for granted, that this river discharged itself at Rhœteum, and as the decision of this question almost includes that of the site of Troy, we must consider it more at large.

Our first argument is, that the Scamander discharges its waters at Sigeum now, that it discharged them "near or towards Sigeum" two thousand years ago, in the time of Strabo, and that there is no decisive evidence that it ever discharged them any where else. Our second, that the appearances of the plain about the mouth of the river indicate that it has confined itself to one side of the plain, and maintained pretty nearly its ancient course. And our third, that whilst the supposition of its discharge at Sigeum during the Trogan war, is perfectly agreeable to the details of the Iliad,

towards Sigeum, and the former towards Rhœteum, unite their streams a little in front of the present (i. e. new) Ilium: and the confluent stream discharges itself at Sigeum, forming first the Stomalimne, or lake of the mouth." (Strabo. p. 579.) See Rennell, p. 28.

that of its discharge at Rhœteum is almost wholly irreconcilable with those details.

To our first statement we apprehend little objection. With respect to our second, in rivers such as we have been describing, which during floods bring down great quantities of alluvial matter, and still more in the case of a river like the Mender, whose current, even in dry seasons, is composed of almost as much sand as water, the mouth obtrudes itself into the sea, and this sometimes to a very great distance beyond the natural line of coast in its vicinity. The Missisippi is an extraordinary instance of this, and perhaps the Scamander little less so, for it has thrown up a neck of firm, solid, sand nearly a mile in length in the direction of its course, that is from Sigeum into the Hellespont. At the extreme point of this projecting land is built the Turkish fort of Koumkala. The formation of this land, we conceive, can be accounted for only on the supposition, that the Scamander has flowed out there for a very long period.

Perhaps, indeed, two thousand years may have been sufficient to produce this effect; but if it be allowed that the embouchure of the river has not changed its place since the time of Strabo, there is no reason for main-

taining that it traversed the whole space between the two promontories, during the thousand years between the age of Strabo and that of the Trojan war.

It is generally inferred that the Scamander has traversed the whole distance from Rhœteum to Sigeum, because the bay between the two promontories has been converted into a marsh since the time of the Trojan war. To this we reply, that as the plain and shore which open on the bay are extremely flat, the bay itself would be shallow in the same proportion, and whatever addition of soil might be necessary for converting it into solid ground, little would be sufficient to convert it into a marsh; and to effect this we conceive the occasional overflowing of the Mender, and the constant addition of alluvial matter from the Thymbrec, to be amply sufficient. The Hellespont itself may have assisted.

There are two openings in the marsh, (see map) which, because they resemble the embouchure of a river, are frequently pointed out as the ancient mouths of the Scamander, and as proofs that it must have traversed the bay. But we believe that these openings, which appear to be nothing more than the remains of the ancient bay, have never given vent to the waters of the Scamander.

Let us now enquire in the third place, whether it be not more agreeable to the descriptions of Homer, that the Scamander discharged its waters at the Sigean than at the Rhœtean promontory.

In considering this point, we can scarcely fail of being struck by the important fact, that no mention is ever made of the Scamander in the *lowest part* of its course. If it ran out at Sigeum, the extremity of the camp, the station of Achilles, near whose post an enemy never ventured to approach, the cause of this silence is evident; the armies never came in contact with the river, and consequently no occasion to mention it could arise. But if the Scamander discharged its waters at Rhœteum, it would in the broadest and deepest part of its course have constantly intersected both Greeks and Trojans, and have embarrassed, if not wholly prevented, many of the actions described as taking place between the two armies, and the perfect silence maintained respecting it would be totally unaccountable.

It would, moreover, on the night when the Trojans encamped on the Throsmos, (Book XI.) not only have divided the Trojan allies, Phrygians and Mysians, encamped in the valley of Thymbra, from their own army, but also have separated them from the

Grecian lines. Yet in the nocturnal expedition of Ulysses and Diomed into Thymbra to steal the horses of Rhesus, though almost every step they took is minutely described, no allusion is made to the river, nor does a single instance occur of its being noticed in any battle fought between the Throsmos and the Grecian camp. But whenever it is introduced, in connexion either with the route of armies, or individuals, it is in the upper part of its course, and even there, where it is of much less magnitude than in the lower, it is generally described as being crossed at a regular ford. In the fourteenth book Hector being wounded is borne from the tumult of the fight to the rear, where he has left his chariot,

"Which drew him groaning back toward the town.
"Arriving at the ford of Xanthus' stream
"Vortiginous, from mighty Jove derived,
"They stretched him on the bank, and on his face
"Poured water." *Iliad XIV.* 510 *to* 515.

On examining what has passed previous to this accident, we find Hector fighting near the station of Ajax, which was at Rhœteum, and had the Scamander flowed out at Rhœteum, Hector was either on its banks when wounded,

or must have travelled alongside it till he reached the ford, both which suppositions are out of unison with Homer's description.(20)

But in the eleventh book we find a description of the field of battle, and transactions occurring in the course of it, which appear clearly to prove that the Scamander discharged itself at Sigeum. Ulysses in assisting Diomed is wounded near the tomb of Ilus, when Ajax comes to his relief, and in his turn attacks the Trojans. Here then we have Ajax fighting near the tomb of Ilus,(21) which stood near the Throsmos, and this we have seen lay on the *Grecian left*, or eastern side of the plain.

When, therefore, the poet remarks immediately after, alluding to the slaughter made by Ajax,

"Whereof Hector yet
"Heard not, for on the *left* of all the war
"He fought beside Scamander,"

Iliad XI, 603.

(20) Had Hector been near the Scamander his attendants would not have conveyed him all the way to the *Fords*, as their only object seems to have been the procuring of water, and that being obtained they proceed with him no farther.

(21) The Tomb of Ilus was not very far from the Throsmos, for we read that Hector and his Council retired thither out of reach of the noise of their own army, then encamped on the Throsmos. (Book V. 475.)

From other parts of the Iliad we find that it was not very far from

the term *left* can mean only the left of *Hector*, or the *Trojans*, that is, to the west of the plain, for Ajax himself was fighting on the Grecian left or eastern side. Hector was moreover "*on the left of all the war*," or as his charioteer just afterwards observes, "*on the skirts of all the battle;*" and as, at the same time, he was "*beside Scamander*," the whole plain on which the armies were contending, must have lain between that river and the Throsmos. By a necessary inference it follows, that the Scamander in the lowest part of its course crossed over from the neighbourhood of New Ilium and the tomb of Ilus on the eastern, to the western side of the plain, and consequently discharged itself at Sigeum. By thus crossing over from one side of the plain to the other, the river would describe a line in some measure parallel to the coast, and thus admit of, and beautifully explain, the position of the Trojan watch fires, described as

"Between the stream
"Of Xanthus blazing and the fleet of Greece.
Iliad VIII. 642.

Strabo says, that in his time the Simois and Scamander formed a junction near New Ilium, and then flowed towards Sigeum.

the Scamander, and if we assign it a position half way between that river and the Throsmos, we cannot be far from the truth.

This is exactly what appears to have been the case at the time of the Trojan war.

Could any doubt remain of the actual position of Hector, when he was "*to the left of all the war beside Scamander,*" it must be dissipated by an anecdote related of Machaon in the eleventh book. At the time alluded to, Machaon, being wounded not far from Hector, is placed in the chariot, and carried off to the tent of Nestor, which, as we have already seen, lay *between Rhœteum and* the centre of the fleet. On his route he passes close under the ships of Achilles, at Sigeum, for it is not at a distance that Achilles sees him whilst he crossed the plain, for he says,

"Viewing him *behind*
"I most believed him Æsculapius' son,
"Machaon, but his steeds so swiftly passed
"My galley, that his face escaped my note.
Iliad XI. 737.

Had Machaon been wounded on the Grecian left, or towards Rhœteum, which is what most authors understand by "*to the left of all the war,*" the poet would not have sent him all across the plain to Sigeum on his way to the centre of the fleet, merely to show him to Achilles, and if he had done so, Achilles would have seen his face in coming towards him, before he viewed him from behind, when retreating.

After a candid consideration of our arguments, and more particularly after an accurate examination of the history of the battle to which we have been referring, we think that all must admit the probability, and some we flatter ourselves will allow the certainty, of the Scamander's discharge at the Sigean promontory during the Trojan war. It is a point on which we have dwelt rather long from its extreme importance, for if our views of it be correct, Troy stood on the *western bank of the Scamander*.

Writers on the Site of Troy and the Trojan Plain.

If we except the early authors who do not aim at any exactness in determining the site of Troy, and Mr. Hobhouse, who appears to be very sceptical in all the historic details of Homer, we may without much impropriety divide all writers on this subject into two classes:—those who follow the authority of Strabo, and those who, with the French traveller Chevalier, consider the village of Bournabashi to occupy the site of ancient Troy.

Strabo himself never visited the Troad, but he has left us much valuable information derived from one Demetrius, a great admirer of Homer, and who resided at Scepsis, an ancient city of Mount Ida, and the name of which, like many of Homer's, still remains. (22)

He informs us that New Ilium, or the modern city, was situated on the plain, at the distance of twelve stadia, or about a mile and a half, from the camp of the Greeks. That the Callicolone, or beautiful hill of the Simois, was at the distance of forty stadia from New Ilium in the direction of Ida, and that between them, at thirty stadia from New Ilium, and ten from the Callicolone, stood the village of the Ilieans, which was supposed to occupy the site of ancient Troy.

Now the remains of New Ilium are still visible, and are identified by many inscriptions; and the distance between it and what probably was the line of coast in the time of Strabo, is about twelve stadia, as he describes it to be. At forty stadia beyond New Ilium, and in the direction of Ida, we find

(22) As Strabo received his account from another, we cannot attach implicit belief to the accuracy of his descriptions. The question, if to be decided at all, must be so by an attentive comparison of the action of the Iliad with the topography of the plain.

a hill of conical shape, that of Atchkieu, answering to the Callicolone of Strabo; and the village of the Ilieans probably stood between this hill and New Ilium. It is in this part of the plain that Rennell and many others place their Troy, on the double supposition that here stood the Ilian village, and that the Ilian village occupied the same spot as the ancient city.(23)

The correctness of the first of these suppositions we will not dispute, it being immaterial, but to the truth of the second we must refuse our assent. In the first place because we cannot find in this part of the plain any spot answering to Homer's description of the site of Troy:—for instance, no warm and cold springs, and no rocky heights for the Pergama: and in the second place, because we have shown reasons for believing that Troy did not stand on this side of the Scamander, but on the opposite or western bank. Since then the situation of the Ilian village as assigned by Strabo will not answer to the site of Troy as described by Homer, let us examine the hypothesis of Chevalier who places Troy at Bournabashi.

This conclusion of Chevalier does not appear to have been the result of careful ex-

(23) See Rennell's "Observations, &c." page 69 and 75.

amination or mature reflection, but a sudden idea that struck him on first visiting the springs we have before alluded to, which he, on being told by his guides that one of them was a warm spring, immediately inferred to be the warm and cold fountains of the Scamander. Impressed with this notion, the hill of Bournabashi instantly presented itself as the Site of Troy, and the rocky heights behind the village as that of the lofty Pergama.

The nature of the place itself and its relation to the plain, and, still more so, the map which he published, agreeing well with the descriptions of Homer, for some time put an end to all controversy on the subject.(24)

Subsequent travellers, however, could find no difference between the temperature of the springs, on the supposed coincidence of which with the fountains of Homer, Chevalier's theory had been founded, and, perceiving his forced interpretation of the text of the Iliad, and finding it utterly impossible to reconcile his account of the rivers with that of Homer and with facts, they returned once again to the authority of Strabo.

(24) "Voyage de la Troade." Vol. II. 191.

Site of Troy.

We must confess, however, that after a careful examination of the Iliad, and a close attention to the topography of the Trojan plain, though compelled to abandon most of the opinions and arguments (25) of Chevalier, we still think him correct in placing Troy at Bournabashi: at least we can find no spot in the Troad which can produce claims of equal plausibility.

We have seen that the Scamander most probably joined the Hellespont at Sigeum, and, consequently, that Troy stood on its western bank. To the west of the Scamander, however, we find no situation which corresponds so well to the site of Troy as that of the village of Bournabashi; and if we can show that the springs, which rise near that village, would to a vulgar eye and a rude nation correspond with the account given by Homer of the two fountains of the Scamander which rose near Troy, the vicinity of

(25) Chevalier considers the Bournabashi stream to be the Scamander, and the Mender the Simois; and his Scamander rises, not in Mount Ida, but at Troy, and discharges itself, not at Sigeum, but Rhœteum. In consequence of this multiplied confusion, yet still holding fast his conviction that he was right as to the site of Troy, he brings forward weak arguments and forced illustrations, and is sometimes obliged to distort facts to prevent them overturning his own theory.

these springs to Bournabashi, added to the strong coincidence which we recognize between both its individual character and relative situation, and those of Troy, will afford a strong presumption in favour of our supposition. We will proceed then, first, to examine the nature of these springs, and, secondly, the points of agreement between the neighbourhood of Bournabashi and the site of Troy. In the twenty-second book of the Iliad, where Achilles is pursuing Hector round the Trojan walls, we find the following description of the Scamandrian fountains.

"And now they reached the running rivulets clear,
"Where (26) of Scamander's dizzy flood arise
"Two fountains, tepid one, from which a smoke
"Issues voluminous as from a fire;
"The other, e'en in summer heats, like hail
"Is cold, or snow, or water fixed by frost.

(26) "Where from Scamander's, *&c.*" *Iliad XXII.* 172.

We have taken the liberty of altering "where from" into where of, the latter being more correct.

The commentators, unable to reconcile the statements of Homer, that the Scamander rose in Mount Ida, and yet that the "fountains of the Scamander" were near the walls of Troy, have boldly asserted that the river on approaching Troy sank under ground, and appeared again at the surface on the Trojan plain:—a circumstance utterly without foundation.

"Beside them may be seen the broad canals
"Of marble scooped, in which the wives of
Troy
"And all her daughters fair were wont to lave
"Their costly garments, whilst the land had
rest,
"And e'er the warlike sons of Greece arrived.
Iliad, XXII, 173.

Respecting the springs of Bournabashi the accounts are contradictory enough. Chevalier does little more than affirm that one of them is hot and the other cold. Morritt declares that one spring is as warm as the hot baths of Bristol; and others again maintain that both are hot, or both are cold. But the experiments of Dr. Clarke (27) have determined the temperature of these springs to be the *same* (viz. 62° of Farenheit's thermometer,) and, in the latitude of the Hellespont, we believe, this degree of heat will entitle them to the character of warm springs. But notwithstanding the indications of a thermometer, we can add our testimony to that of every traveller who has visited the Troad, that there exists a current belief amongst the natives, that the spring nearest to Bournabashi is a warm one. Dr. Clarke himself appears to have been most forcibly struck

(27) Travels in Asia Minor. Vol. II. p. 110.

with the appearance of this spring. He says, "it gushes perpendicularly out of the earth, rising from the bottom of a granite and marble reservoir, and throws up as much water as the famous fountain of Holywell. (28) "Its surface seems vehemently boiling, and during cold weather the condensed vapour above it causes the appearance of a cloud of smoke over the well." And he adds, that, "the marble and granite slabs which form the basins appear to be of the highest antiquity." The testimony of Sir William Gell is still more important. He states that he saw the smoke or steam over the source nearest Bournabashi, (the reputed warm spring) and that the water felt warm to the touch. The other spring, which was of like temperature at the mouth, did not send up any steam from its reservoir.

It is not difficult to account for the apparent difference of temperature between the two springs. The warm spring rises in a single jet of water into a small reservoir, where it always retains its primitive temperature. The neighbourhood of this reservoir is low and marshy, and it is completely en-

(28) In this, however, we cannot agree with Dr. Clarke, but should think that half the quantity of water thrown up at Holywell would rather exceed, than fall short of, that ejected by the spring in question.

veloped with trees; the air over it is consequently highly charged with moisture, and the vapour from the spring will be condensed, and become visible much sooner than if the surrounding atmosphere were dry.

The water of the cold spring, on the contrary, being distilled from many crevices into a large reservoir, is actually of a lower temperature than the sources by which it is fed, and than the water in the other reservoir. In addition to this, as it lies in an open and exposed situation, the surrounding atmosphere is dry, and consequently the vapour from this reservoir, even had it been of the same temperature, which it is not, as the other, would neither so soon become visible, nor ever be so dense. In cold weather the real difference of temperature between the water of the two reservoirs will be much increased, for whilst that in the small one, or warm spring, will always retain its primitive heat, that in the large one, or cold spring, may be cooled down to almost any degree.

But it is unnecessary to say more on this point, for whatever causes induce a belief *now*, that these springs are, one warm and the other cold, would be equally able to produce a similar belief in the age of Homer; and the business of the poet being widely

removed from that of the philosopher, Homer, instead of a critical examination of facts, would merely adopt the current tradition, superstition, or belief, of the natives. There is a further coincidence between these springs and those of Homer, which may be noticed. We found the women of Bournabashi washing their linen here, as in the Scamandrian fountains of old,

"The Trojan dames, e'er yet alarmed by Greece,
"Washed their fair garments in the days of peace."

We should have scarcely mentioned so trivial a circumstance had not Dr. Clarke observed, "that the women of this place (Bournabashi) brought their garments to be washed in these springs, not according to the casual visits of ordinary industry, but as an ancient and established custom, in the exercise of which they proceed with all the pomp and songs of a public ceremony." This general belief then, that one spring is warm and the other cold, added to the other circumstances we have mentioned, and the striking character of the fountains themselves, are, we think, fair grounds for believing them to be those of the Scamander which rose near Troy; and, if they are so, Bournabashi beyond all doubt occupies the site of Troy.

Considering, then, Bournabashi to occupy the site of the ancient city, the high rocky eminence behind the village answers extremely well to Homer's description of the situation of the lofty Pergama; and its position, relatively to the city and Scean gate, will also be found correct:—for the Scean gate lay towards the plain, the Pergama more inland, and the city between the two. This is evident from the course of Hector when in search of Andromache: he passes from the Scean gate to the Pergama, where she resided; but, not finding her, he is described as retracing his steps through the city, and meeting her at the gate.

No rising ground intervenes between Bournabashi and the sea, but the whole plain is visible from it, which appears also to have been the case from the walls of Troy. Bournabashi cannot be approached from the plain without crossing the Scamander, which was likewise the case with Troy.

The numerous slabs of marble and broken columns in and about Bournabashi unquestionably prove some ancient city to have stood there; and it would be unpardonable not to mention the foundation of an old wall of squared stones encircling part of the rock, which we now call the Pergama.

The lively imagination of Chevalier distinguishes amongst these ruins the palace of Priam, Hector, Æneas, and some other heroes; but what data he can have for these fancies we are at a loss to conceive.

Such are our principal grounds for believing that Bournabashi occupies the site of ancient Troy. Its lying on the western bank of the Scamander, the existence of two such singular springs in its vicinity, the character of the hill itself, the remains of old masonry, and pieces of marble and granite found upon and about it, its situation relative to the plain, the sea, and the rivers, must be allowed to form a strong presumption in its favour; and we have little hesitation in saying, that had Chevalier's account of the rivers been reconcilable with actual facts, and with the Iliad, and his springs been really warm and cold, or good reason shown why such a belief should exist, instead of being regarded merely as an innocent enthusiast, he would to this day have enjoyed the glory of deciding this interesting question. It is now time to consider, as briefly as we can, the objections to which this hypothesis is exposed.

The first is a difficulty of our own creating, for having changed Chevalier's rivers, but retained his site of Troy, we have thrown the

city without the plain bounded by the Simois and Scamander, and where all writers, we believe, suppose that it stood.

There appear, however, no other grounds for this supposition than the following: first, that only one stream, the Scamander, is mentioned as being crossed, in passing from the fleet to the city, whereas in the case we suppose, both Simois and Scamander must have been crossed by the armies: and secondly, that as in the beginning of the sixth book the battle which commenced under the walls of Troy is represented as still being waged,

"With various fortunes on the *middle plain*
"By Simois laved and Xanthus' gulfy stream,

it is fair to conclude that Troy itself stood on the middle plain.

With respect to the first reason, the silence preserved about one river is fully accounted for by the insignificant size of the Simois, which, presenting no impediment whatever to the passage of an army, need never be alluded to in connexion with such an event. As to the second reason, we reply, that by attentively tracing the movements of the armies in the latter part of the fifth book, we shall find the Greeks in full retreat to their camp, and that at the commencement of the sixth book they must have been already far

from Troy, and of necessity, from their line of retreat, would then be in the middle plain. As the Greeks "step by step retired," they would repass the Scamander without difficulty or confusion, and, consequently, no more occasion would arise for mentioning the passage of the river, when retreating, than when advancing; and on the advance of the Greeks to Troy it must have been crossed, whatever the theory, and yet no allusion is made to it. Indeed the armies so often cross the Scamander without any notice being taken of it, that in the above instance the silence of the poet is not at all extraordinary, nor can any argument be founded upon it. If this explanation be deemed satisfactory, it may be added, that the supposition of Troy standing without the middle plain, encounters no difficulty in any other part of the Iliad.

The second and principal objection to Bournabashi as the site of Troy is founded on its great distance from the sea and Grecian camp. This is considered by many, and by Rennell in particular, as decisive against it, and they rest their proof on Homer's description of the battle, which, beginning with the eleventh book of the Iliad, concludes only in the middle of the eighteenth. Besides

the time consumed in storming the Grecian lines, which must have been considerable, the armies are represented to have traversed the plain, from the camp to the city, no less than four times, and that too between the hours of noon and sunset. This distance according to Rennell is nearly twenty-eight miles, and that the armies should actually have traversed so great a space in so short a time is certainly in the highest degree improbable, if not absolutely impossible. But there is an easy, and perhaps satisfactory, method of explaining this, or any other difficulty of a similar nature, Homer we know to be most exact in his topography, and describing as accurately as he was intimately acquainted with his scenes, no one has been able to convict him of an error. But the actions of his poem rest on a different foundation: he did not witness them; he must therefore have followed some circumstantial account handed down by verse, or tradition; or else his knowledge of the events must have been merely general, amounting, perhaps, to nothing more than a bare outline.

In the former case, to have crowded the events of two days into one is a slight error to have crept into an account in the course of three hundred years; and in the

latter, there is no reason why Homer should not make his heroes travel an extraordinary distance, as well as endue them with supernatural strength, swiftness, and power of sight; make the voice of Agamemnon heard over a space of two miles, and the shout of Achilles strike terror through the whole Trojan army. Homer is a faithful painter, but in the actions of his poems he indulges in the exaggeration of a poet.

In the particular case before us, however, that of the battle quoted by Rennell, we can give something more than a general answer, for, by minutely tracing the transactions of the battle alluded to, we shall find them, not only too numerous and extensive for one day, even had Troy stood within half a mile of the Grecian camp, but so confused in the detail, that either some error must have existed in the account from which Homer derived his knowledge, or that his accustomed accuracy and perspicuity must have here deserted him. In the first place, we find the hour of noon *twice described* in the course of the battle, and this, not immediately in succession, but separated by more than half the actions of that eventful day.

The battle commences on the Throsmos before the Grecian lines, and was contested with

are confident that no argument whatever would have been founded upon it.(30)

It is farther objected, that if Troy stood at Bournabashi, its distance from the shore would be too great to admit of the transactions recorded in the eighth book of the Iliad. We read there, that the Greeks, being vanquished and shut within their ramparts, are saved by the approach of night. The Trojan army encamps on the Throsmos, and Hector, calling a council, gives the following charge to his troops.

"With despatch
"Drive hither from the city fatted sheep
"And oxen, bring ye from your houses bread,
"Make speedy purchase of heart-cheering wine,
"And gather fuel plenteous."

Had Troy, it is said, been distant from the Trojan camp seven or eight miles, it would have been mere mockery to have told them to go home to procure refreshment, as an attack on the Grecian camp was announced for

(30) Since this Essay was read to the Society, a work on the same subject has made its appearance from the pen of Mr. Charles Maclaren, for a short outline of whose theory see Appendix. Mr. Maclaren is aware of the confusion which exists in the account of this battle, and so decisive does it seem to him, that he totally abandons the argument founded upon it, and looks elsewhere for proofs that Troy stood at no great distance from the shore.

day break. Judging merely from such an order, we should not have supposed the city distant more than three or four miles, but, after an attentive examination of the case, we shall find it not inconsistent with a distance considerably greater.

The council met at the tomb of Ilus, while the Trojan army was encamped on the neighbouring Throsmos. The Throsmos, we have seen, was, in all probability, the hill of New Ilium, which is distant from Bournabashi only six miles, and thus the Trojans would have a distance to travel of not more than twelve miles, which might be accomplished in less than four hours, including the time spent in the city. If, therefore, we suppose, which it is fair to do, that day and night were equal, no less than eight hours would be left to the troops for supper and repose, an allowance very liberal under the circumstances; and surely it was more advisable for Hector to issue the orders he did, than by allowing his troops to retire home for the night abandon the advantages already gained, or by allowing them to remain supperless on the field have to lead them to battle in the morning hungry and out of heart.

It was on the same night that the expedidition of Ulysses and Diomed into the camp

of the Trojan allies took place. They found the Trojans lost in sleep, no doubt after their return from Troy; for when the Greeks commence their expedition, two-thirds of the night are already gone.

"Two parts have nearly passed
"Of darkness, but the third is yet entire.
Iliad. X. 390.

The poet, therefore, is perfectly consistent in his account, when he represents *the Trojan army* being found in a *state of repose*, as four hours must have then elapsed since the return of the troops from Troy.

We flatter ourselves that after an attentive review of our arguments, the distance of Bournabashi from the sea or the Throsmos will not be considered an insuperable obstacle to its being the site of Troy.

The only remaining objection to our hypothesis is the difficulty which the rocks of Bournabashi might present to the course of Achilles and Hector round the Trojan walls. Chevalier attempts to show that they only performed circles before the walls, and did not actually compass the city in their flight. We are not, however, aware that there is any insuperable impediment to a person running round the rocks of Bournabashi. The distance is indeed great, but perhaps the

heroes ran only once, and not thrice round the city, or possibly the whole circumstance may be a fiction of the poet: at all events it is a matter of trifling importance.

At a short distance from the remains of the old wall, on the rocks of Bournabashi, and without it, is a tumulus of loose stones, which Chevalier has called the tomb of Hector. It may possibly be the tomb of that hero, for in the Iliad it is described as being a heap of stones, near, but not in the city.

Clarke rather hastily asserts that if this wall be the remains of the Trojan one, the tumulus cannot be that of Hector; and that if this be the tumulus of Hector, that cannot be the wall of Troy:—because, says he, Hector was buried within the city. Every line, however, of Homer's account of the funeral-rites of Hector shows that his tomb was not within the city. Besides the unusual custom, and the danger of having so large a funeral-pile lighted within the city, Hector would not have been "borne out:"—Troy would not have "thronged forth;" nor need spies have been set to guard against an attack of the Greeks:—all which things are represented to have taken place. (Iliad XXIV. at the end.)

At the distance of four or five miles from

the village of Bournabashi, crowning the summit of a ridge of hill which bounds the Trojan plain on the west, is the Udjec Tepé, a stupendous tumulus, which, commanding a noble view of the surrounding country, and a most complete prospect of the plain, has generally been considered as the tomb of Æsyetes, where the swift-footed son of Priam was sent to reconnoitre the motions of the Greeks.

"Polites who confiding in his speed
"Sat posted high on Æsyetes' tomb
"To watch the Grecians coming."

Iliad, II. 919.

Rennell, however, and some others, think the tomb of Æsyetes must have been on the plain, and near the camp of the Greeks. They object to the great distance of the Udjec Tepé, and say that it was unnecessary to send a swift runner, as from the relative position of the places there was no danger of being either overtaken or intercepted. But we are still of opinion that the Udjec Tepé is the tomb of Æsyetes, and that if Bournabashi be the site of Troy, no point of observation could have been better chosen, not, perhaps, for prying into the Grecian camp, but for watching the motions of the Grecian armies, which at that moment,

"Covered the Scamandrian plain:
"They overspread Scamander's grassy vale,
"Myriads, as leaves, or as the flowers in spring.

As this tomb is only once mentioned in the Iliad, and from the use it is then applied to must have been lofty, either in itself, or in its situation, it could not have stood on the plain where the armies fought, or we should hear of it frequently, as of the tomb of Ilus. We should at once infer from the account given of it, that it occupied some commanding situation on one side of the plain, or, in other words, just such a point as that where we find the Udjec Tepé. And if Polites did not quit his post, which it appears he did not, until long after the advance of the Grecian army, his speed would not be useless to him in returning to the Scean gate.

There are still to be found some mounds on the plain, which may be those of Myrinne, which

"Lifts its head in Ilium's front,"

and of Ilus, where Hector held his nightly council, but they cannot positively be identified. Indeed almost every tomb in the lower part of the plain has by turns been taken for that of Ilus. Of the Grecian ramparts there are no remains, which considering the

nature of the ground can scarcely be deemed extraordinary, and Homer says that even before his time they had been levelled by inundations of the rivers. The great tomb of Ajax is still to be seen crowning the summit of Rhœteum: it is a noble object and subject to fewer learned doubts than any other Homeric monument in the Troad.

There are two tumuli standing side by side on the projecting shore of Sigeum, which have for 2000 years been called the tombs of Achilles and Patroclus. Strabo mentions a third which he allots to Antilochus. Respecting the smaller of the two tumuli at least, we must be allowed to express our doubts of its being properly designated, for both in the Iliad and Odyssey it is distinctly stated, that the ashes of Achilles and Patroclus were placed in the same urn, and one tumulus raised over it. An ambiguity in the original prevents its being exactly ascertained whether the ashes of Antilochus were placed in a separate urn, or only in a separate division or compartment of that which contained the ashes of Achilles and Patroclus. Cowper translates the passage in the former sense, and says,

"*Each urn* we compassed with a noble tomb
"On a tall promontory shooting far

"Into the spacious Hellespont, that all
"Who live, and who shall yet be born, may view
"Thy record even from the distant waves,
Odyssey, XXIV. 80 *to* 90.

We think the most probable conjecture is, that the larger of the two tumuli covers the urn of Achilles and Patroclus, and the smaller one that of Antilochus. These tumuli were opened by a Jew, employed for the purpose by Chevalier, and an urn and some curious ornaments, reported to have been found in them, are described in his work on the Troad, and engravings of them published amongst his plates; but as the Jew is supposed to have played on the credulity of his master, we shall omit any further notice of the circumstance.

Much has been said and written on the epithet "broad," so frequently applied by Homer to the Hellespont, and the most ingenious, as well as frivolous explanations, have been invented to save the credit of the poet, in giving so extravagant an appellation to so narrow a sea. But the Hellespont is not a sea; to those standing upon its banks, it conveys no idea but that of a river, and whilst they watch its mighty current

"Roll darkly heaving to the main,"

they will confess, that the epithet broad is as descriptive and appropriate as any to be found in Homer.

The results then of our present investigation, if our arguments be correct, are the following.

1. That the poems of the Iliad and Odyssey attributed to Homer were actually written by him.

2. That the arguments brought forward by Bryant and others against the existence of Phrygian Troy and the Trojan war are unsatisfactory, and opposed to the universal belief of ancient times.

3. That the plain extending from the village of Bournabashi to the Hellespont, and bounded by the promontories of Sigeum and Rhœteum, is the plain of Troy, the undoubted scene of the actions recorded in the Iliad.

4. That the Scamander at the time of the Trojan war discharged its waters at Sigeum, and, consequently, that Troy must have stood on its western bank.

5. That on the western bank of the Scamander there is no situation at all answering to the site of Troy but that now occupied by Bournabashi.

6. That the great distance of Bournabashi from the sea by no means presents an insu-

perable objection to this supposition, since the narrative of the battle, in books eleven to eighteen, on which the objection mainly rests, is so confused, that no argument can be founded upon it.

7. That the springs of Bournabashi are the warm and cold fountains of the Scamander, near which Hector was killed.

8. That the hill of New Ilium is the Throsmos of Homer.

9. That the Udjec Tepé answers well to the situation and character of the tomb of Æsyetes.

10. That the mound of loose stones on the rock behind Bournabashi may possibly be the tomb of Hector.

11. That the great tumulus on Rhœteum is the tomb of Ajax.

12. That, of the two tumuli at Sigeum, it appears most probable, that one covers the ashes of Achilles and Patroclus, and the other those of Antilochus.

But to conclude: what inference shall we draw from this close coincidence between Homer's descriptions, and the present appearances of the Trojan plain; from the existence of rivers, such as he describes; from the tumuli being yet found on the spots to which he alludes, and from the names of the

Iliad remaining still applied to the same objects as in the days of Homer? Shall we, like Mr. Bryant, infer that Troy was merely the creature of his imagination, or, that if it ever had existence, it must be sought for in Egypt?—Or that a war between the Greeks and Trojans never took place, and that Homer invented all the action of his poems, adapting it to the scenery of this plain, and connecting it with the rivers, tumuli, springs, and other features natural and artificial, which struck his eye on contemplating the landscape?—Shall we *so believe*, and that a credulous world has for centuries been mistaken, and attached credit to the pleasing fictions of a poet, due only to the relations of a scrupulous historian?—Or shall we not rather turn to the opposite conclusion:—that Troy *did exist* where Homer places it, where ancient historians believed it to have stood; and that the coincidences between the present scenery of the Troad and that of his poems, and the actual existence of monuments described, or alluded to therein, tend to confirm the truth of the facts which he relates, and consequently to strengthen the foundation of early Grecian history.

The scenery presented to the eye of the traveller in the Troad is beautifully rich, picturesque, and sublime. From the smooth and fertile plain, the eye turns with pleasure to the snowy peaks of Ida, the blue Egean, the isles of Samothrace, Tenedos, and Imbros, and the stupendous mount Athos, which, though at distance of 100 miles, forms a prominent feature in the landscape. And when he beholds, realised to his view, the scene of those actions which inspired the mighty poet; the fields where those battles were fought,—the delight of his early years; and the grassy mounds which cover the ashes of his well known heroes,—of the gentle Hector at whose fate he has wept, and of the angry Achilles at whose rage he has trembled: when he beholds the dizzy Scamander rolling at his feet,—the broad Hellespont extended before him,—those lofty peaks, the course of Juno's chariot,—and *that*, the throne of Jove himself; the scepticism, which at a distance may have obscured his belief in the records of Homer, will here vanish like mist before the blaze of day, and he will exclaim with the poet,

"Minstrel! with thee to muse, to mourn,
"To trace again those scenes of yore,
"Believing every hillock green
"Contains no *fabled* heroes' ashes,

"But that around the undoubted scene
"Thine own "broad Hellespont" still dashes,
"Be long my lot! and cold were he,
"Who there could gaze denying *thee!*

APPENDIX.

THE publication of Mr. Maclaren's work, entitled "A Dissertation on the Topography of the Plain of Troy," (Edinburgh 1822) is an additional proof, were any wanting, that the interest excited by this question is not yet subsided. As Mr. Maclaren takes a different view of the subject from any we have been discussing, a short outline of his theory, and a few remarks upon it, appear to be in some measure called for. He supposes that New Ilium occupies the site, and was raised on the ruins of ancient Troy. That the Grecian camp could not have been so large, as to cover, in triple row, the space between Rhœteum and Sigeum, and, consequently, that these two promontories are not those alluded to by Homer. He maintains that the sandy point of Koumkali is one of Homer's promontories, and the opposite one, (see map, B,) across the present course of the Scamander, the other, and that the ships were drawn up between these two jutting points, in lines five ships deep. The Mender he considers to be

the Scamander, but, like other writers, makes it discharge itself at Rhœteum. The Thymbrec he maintains to be the Simois of Homer, and he certainly shows fair grounds for believing, that it is the river described by Strabo as the Simois. The hills behind Sigeum are his Throsmos.

Such is a brief outline of Mr. Maclaren's notions about the topography of the Trojan plain, and we must allow him much merit for the novelty of his views, the ingenuity of his arguments, and his accurate study of the Iliad. Many of his observations coincide exactly with our own, particularly those which relate to the distance of the Throsmos from the Grecian camp, the position of the tomb of Ilus, and the objections he makes to the opinions of Chevalier, Clarke, and Rennell.

But respecting the main points of his theory we must be allowed to offer a few remarks.

He places the Grecian camp where we now find a marsh, and where most probably the sea flowed at the time of the Trojan war. Of his low sandy projections or promontories, we doubt much if one ever existed at all, and still more whether the other was in existence 3000 years ago. Above all, we think that the theory has a very weak foundation, which is grounded on the supposed stability,

or change of shape, in an alluvial coast, during a period of thirty centuries,—of which no correct survey has ever been made, and which has never been visited by the author of the theory. We have, we think, fairly shown, that the vessels enumerated by Homer would, with allowance for passages, tents, forum, and the width of the Scamander, in a triple line, occupy the whole space between the two promontories of Rhœteum and Sigeum: and, if the universal belief be correct, as we doubt not but in this case it is,—that these are the promontories alluded to by Homer, Mr. Maclaren's theory falls to the ground; for he will himself admit, that the distance between Rhœteum and New Ilium is much too small to admit of the actions which took place between Troy and the Grecian fleet.

We will not say that Strabo is decidedly against Mr. Maclaren's opinions, for the appeal must finally be made to Homer and the Trojan plain; but it seems singular that he who founds so many of his arguments on the authority of Strabo, should nevertheless flatly contradict him in the main point. Moreover, Troy could not have stood where New Ilium does, if the Scamander flowed into the Hellespont at Sigeum; for in that case the river would not have flowed between

the fleet and city,—an admitted fact. We have not in Mr. Maclaren's book discovered any new argument to show, that the Scamander flowed out at Rhœteum, nor any thing which makes us suspect the correctness of our conclusion that its embouchure was at Sigeum. And, after all, the most important point to be ascertained is, at which of the two promontories the Scamander did discharge itself in the time of Homer; for if, as we have endeavoured to prove, it discharged itself at Sigeum, all the other theories, which involve the supposition that it flowed out at Rhœteum, necessarily fall to the ground. We cannot finally conclude, without recommending Mr. Maclaren's work to the attentive perusal of those who take any interest in the discussion of the question,—"Where is the Site of Troy."

Drawn by R. H. Grey

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ON THE

TRANSVERSE STRAIN,

AND

STRENGTH OF MATERIALS.

By Mr. EATON HODGKINSON.

(Read March 22d, 1828.)

1. THE lateral strength of materials is a subject which has engaged the attention of the greatest mathematicians; but our knowledge of the action of the fibres or particles of bodies during their flexure, chiefly perhaps for want of sufficient experiments, seems still to be very imperfect. Much then will not be expected from an individual whose means of making those experiments must necessarily be small, and whose knowledge is so contracted, in comparison with that of the illustrious personages who have preceded him.

2. The intention of the writer is, first to unite in a general formula the commonly re-

ceived theories, in which all the fibres (with the exception of those on the edge of a bent body) are conceived to be in a state of tension: and next to adapt the investigations to the more general case, where part of the fibres are extended, and part contracted, and to seek experimentally for the laws that regulate both the extensions and compressions.

PART I.—*Theoretical.*

3. Suppose a beam ABCD, (fig. 1.) fixt firmly in a wall, and then broke by a weight W, suspended at one of its ends.

When the fracture commences the fibres at *ac* separate the first; next, those immediately under them, and so on till the whole depth, *ab*, is broke; with the exception of the lowest stratum, *b*, which is supposed to be incompressible, and serves for a fulcrum to the bended lever D*ba*. It is evident then, that, whatever the extension of a fibre at *a* may be, the extension of one at *x* must be in proportion to it, as *bx* to *ba*: or the extensions must vary as the distances from the fulcrum *b*. Let us then call the length D*b* = 1, the depth *ba* = *a*; any variable distance *bx* = *x*, the breadth of the beam at bottom = *b*, any double ordinate *de* = *y*; the

strength or utmost tension of a fibre at distance $a = s$, and let the tension of a fibre be designated by any power v of its extension.

We have then $a^v : x^v :: s : \frac{sx^v}{a^v}$ = the force exerted by a particle at x, which multiplied by y, gives $\frac{syx^v}{a^v}$ = the force of all the particles in de; and this multiplied by x, its distance from b, gives $\frac{syx^{v+1}}{a^v}$ = the momentum of cohesion of de: and the sum of the momenta of all the de will be equal to the weight hung at D, or the whole strength of the beam.

4. For example: Suppose the beam to be a rectangle, as a common joist; then de will be constant, and equal to b, and the expression of its strength will be $\frac{sbx^{v+1}}{a^v}$; and the strength of the joist $= \frac{sb}{a^v} \times$ sum of all the x^{v+1}. If then the distance, ba, be supposed to be divided into an infinite number of parts of equal breadth, the line de may be considered one of those parts, and x will assume all the various values 1, 2, 3, &c. to infinity, or a. The foregoing expression for the strength will then become $\frac{sb}{a^v} \times (1^{v+1} + 2^{v+1} + 3^{v+1} + \&c.\text{ to } a^{v+1}) = \frac{sb}{a^v} \times$

$\frac{a^{v+2}}{v+2} = \frac{sba^2}{v+2}$, (since by summation of series $\dot{1} + \dot{2} + \dot{3} + \dot{4}$ &c. to $\dot{m} = \frac{m^{n+1}}{n+1}$, m being infinitely greater than the unity here made use of.)

And if $v=o$, the strength, or $\frac{sba^2}{v+2}$, becomes $\frac{sba^2}{2}$, which is the theorem of Galileo.

If $v = 1$, or the forces are as the extensions, the strength is, $\frac{sba^2}{3}$; and this is the theorem of Mariotte and Leibnitz. And according to one or other of these suppositions, authors have generally estimated the strength of materials.

5. Again: Let the section of fracture be the frustum ABCD, (fig. 2.) of a triangle. Then if a be the height of the segment, b its base, h the whole height of the triangle, and x any variable distance from AB as before, we shall have $h : b :: h-x. : \frac{b}{h}(h-x) = de$, or y, which substituted in the foregoing formula $\frac{syx^{v+1}}{a^v}$, will give, $\frac{sb}{ha^v} \times \left(\frac{x^{v+1}}{hx} - x^{v+2}\right)$ = the strength of de. And if as before the distance a be divided into an infinite number of equal parts, whereof the breadth of de is one, the strength of ABCD will be express-

ed by $\frac{sb}{ha^v}\Big(h \times \big[{}^{v+1}_{1} + {}^{v+1}_{2} + {}^{v+1}_{3}$ &c. to $a^{v+1}\big] - \big[{}^{v+2}_{1} + {}^{v+2}_{2}$ &c. to $a^{v+2}\big]\Big)$ which, by summing the series as before, becomes

$$\frac{sb}{ha^v}\left(\frac{ha^{v+2}}{v+2} - \frac{a^{v+3}}{v+3}\right) = \frac{sb}{h}\left(\frac{ha^2}{v+2} - \frac{a^3}{v+3}\cdot\right)$$

6. And if the strength of the whole triangle be sought, it will, putting $a = h$, be expressed by $sbh^2\left(\frac{1}{v+2} - \frac{1}{v+3}\right)$.

If then $v = o$, the strength $= \frac{sbh^2}{6}$, as with Galileo. And if $v = 1$, strength $= \frac{sbh^2}{12}$, which is the value according to Leibnitz.

7. Now from the form of the expression, $\frac{sb}{h}\left(\frac{ha^2}{v+2} - \frac{a^3}{v+3}\right)$, which designates the strength of ABCD, it seems probable that there may be some height, a, less than h, at which the frustum may resist with more energy than the whole triangle:—We will put the fluxion of $\frac{sb}{h}\left(\frac{ha^2}{v+2} - \frac{a^3}{v+3}\right) = o$, and seek for the height at which the strength would be greatest. We have then $\frac{sb}{h}\left(\frac{2ha\dot{a}}{v+2} - \frac{3a^2\dot{a}}{v+3}\right) = o$ And by division, $\frac{2h}{v+2} - \frac{3a}{v+3} = o$. Or $a = \frac{2v+6}{3v+6}\cdot h$. Where if $v = o$, or all the fibres resist with

equal forces, $a = h$. If $v = 1$, or the forces are as the extensions, $a = \frac{8}{9}h$. And this last is a confirmation of the disputed assertion of Mr. Emerson, who, on the supposition of perfect elasticity in the fibres without their contraction, says, at page 114 of his Mechanics, that if $\frac{1}{8}$th of its height be cut from the top of such a beam, parallel to the base, the remainder will be stronger than the whole.

It will however appear from the foregoing general value of a, that, if the bottom of the beam be incompressible, as is generally assumed, the assertion is true under every supposition of force, except that of Galileo: And that is an hypothesis, which, when applied to all kinds of bodies, cannot, it seems probable, be long considered sufficient to measure the forces of lateral cohesion.

8. Now if we wish to obtain that point, at which, the top part being cut off parallel to the horizon, the remainder shall be as strong as the whole, we must equate the two values of the strength of ABCD and AhB, or put $\frac{sb}{h}\left(\frac{h\,a^{v}}{v+2} - \frac{a^{3}}{v+3}\right) = sbh^{v}\left(\frac{1}{v+2} - \frac{1}{v+3}\right)$ and from these, by reduction, we get a, or the height =

$$\left(\pm\sqrt{\frac{1}{4}\left(\frac{1}{v+2}\right)^2+\frac{1}{v+2}}+\frac{1}{2v+4}\right)h.$$ *

Where if $v=o$, as in Galileo's hypothesis, $a=h$, or the whole beam is stronger than any part of it. If again $v=1$, as with Mariotte, we have $a=.76759.h$ where nearly $\frac{1}{4}$th of the height may be cut off from the top, and the remainder be as strong as the whole beam.

9. If however we should wish to find the strength of a beam whose form was such that the forces exerted by its fibres could not be

* The process is thus:—Since $\frac{sb}{h}\left(\frac{ha^2}{v+2}-\frac{a^3}{v+3}\right)=sbh^2\left(\frac{1}{v+2}-\frac{1}{v+3}\right)$ we have by division and transposition $a^3-\frac{v+3}{v+2}.ha^2+\left(\frac{v+3}{v+2}-1\right)h^3=o$, a cubic equation: But as one of its roots is evidently $=h$, we may, by dividing it by $a-h$, depress it to a quadratic;

Thus $\frac{a^3-\frac{v+3}{v+2}.ha^2+\left(\frac{v+3}{v+2}-1\right)h^3}{a-h}$ (putting n for $\frac{v+3}{v+2}$) $=\frac{a^3-nha^2+(n-1)h^3}{a-h}=a^2-(n-1)ha-(n-1)h^2=o$.

Whence $a=\left(\pm\sqrt{\frac{1}{4}(n-1)^2+n-1}+\frac{n-1}{2}\right).h.$

And substituting for n, we have

$a=\left(\pm\sqrt{\frac{1}{4}\left(\frac{1}{v+2}\right)^2+\frac{1}{v+2}}+\frac{1}{2v+4}\right)h$, as above.

summed by the mode used in the preceding examples; we might (retaining the first figure and the same notation) suppose the breadth of any double ordinate as *de* to be $= \dot{x}$, and since the momentum of cohesion of *de* was found to be $\frac{sy\,x^{v+1}}{a^v}$, (art. 3d.) its breadth being unity, its momentum will in this case be expressed by $\frac{sy\,x^{v+1}\,\dot{x}}{a^v}$. And the sum of these momenta, or the fluent of $\frac{sy\,x^{v+1}\,\dot{x}}{a^v}$, when $x = a$, will be equal to $l \times W$; where l is the length Db, and W the weight to bend or break the beam.

But if the flexure of the body be worth taking into the account, the effective leverage will not be Db but Eb, a line perpendicular to the action of the weight; and which will be to Db, or l, as cosine of deflection DbE to Radius. Whence $Eb = \frac{Db \times \text{cosin. defl.}}{\text{Rad.}}$ $= l \times$ cosin. Deflection, and the resistance of the body $= \int \frac{sy\,x^{v+1}\,\dot{x}}{a^v} = l \times W \times$ cosin. Deflection. W, therefore, $= \int \frac{sy\,x^{v+1}\,\dot{x}}{a^v \times l \times \text{cos. Defl.}}$

Corol. 1st. If $v = o$, or all the fibres re-

sist with equal forces, $\int \frac{syx^{v+1}\dot{x}}{a^v}$ (putting the double ordinate de for $y\dot{x}$, the fluxion of the surface) $= s\times$ Sum of the $de \times x = s \times$ the section of fracture $\times$ dist. of its centre of gravity from b: which distance if called g, will give $\int \frac{syx^{v+1}\dot{x}}{a^v} = sg \times$ section; and $W = \frac{sg \times \text{section}}{l \times \text{cos. Defl.}}$.

Cor. 2d. If $v = 1$, or the extensions are as the forces, $\int \frac{syx^{v+1}\dot{x}}{a^v} = \frac{s}{a} \times$ Sum of the $de \times x^2 = \frac{sgp}{a} \times$ the section, where p is the distance of the centre of percussion of the section of fracture, and g that of gravity, as before (Emerson's Mechanics, Prop. 57, Cor. 1).

But since $\frac{sgp}{a} \times$ the section $= \int \frac{syx^{v+1}\dot{x}}{a^v} = l \times W \times$ cos. Defl.; we have $W = \frac{sgp \times \text{section}}{a \times l \times \text{cos. defl.}}$.

10. In the preceding investigations we have, agreeably to custom, supposed that the compressed fibres or particles were confined to a very small space on the edge of the beam; and that all the rest were in a state of tension, less or more. And this may probably be not far from the case in such bodies as glass or marble: But (as Dr. Robi-

son* has shown in his valuable Essay on the Strength of Materials, in the Encyclopædia Britannica) it is, when applied to timber, highly erroneous.

11. Dr R. quotes some experiments of Du Hamel, which, as they appear to be very interesting, I will transcribe. They are as follow: "He took 16 bars of willow, 2 feet long, and $\frac{1}{2}$ an inch square, and supporting them by props under the ends, he broke them by weights hung at the middle. He broke four of them by weights of 40, 41, 47, and 52 pounds; the mean is 45. He then cut four of them $\frac{1}{3}$ through on the upper side, and filled up the cut with a thin piece of harder wood stuck in pretty tight. These were broken by 48, 54, 50, and 52 pounds; the mean of which is 51. He cut other four $\frac{1}{2}$ through, and they were broken by 47, 49, 50, and 46 pounds; the mean of which is 48. The remaining four were cut $\frac{2}{3}$ds; and their mean strength was 42."

"Another set of his experiments," continues the Doctor, "were still more remarkable. Six battens of willow 36 inches long and $1\frac{1}{2}$

* And more recently Mr. Peter Barlow, in his excellent "Essay on the Strength and Stress of Timber"— a work which I was unacquainted with when this paper was read.

square were broken by 525 pounds at a medium."

"Six bars were cut $\frac{1}{3}$d through, and the cut filled with a wedge of hard wood stuck in with a little force; these were broke with 551. Six bars were cut $\frac{1}{2}$ through, and the cut was filled in the same manner; they broke with 542. Six bars were cut $\frac{1}{4}$ths through; they broke with 530. A batten cut $\frac{1}{4}$ths through, and loaded till nearly broken, was unloaded, and the wedge taken out of the cut. A thicker wedge was put in tight so as to make the batten straight again, by filling up the space left by the compression of the wood; this batten broke with 577 pounds."

"From this," Dr. R. remarks, "it is plain that more than $\frac{1}{3}$ds of the thickness, perhaps nearly $\frac{1}{4}$ths, contributed nothing to the strength."

12. It appears from these experiments, that in the fracture of willow, a considerable compression takes place, and it doubtless would do to a certain degree in that of every other body.*

We know too that extension of the remain-

* Mr. Barlow has shewn that it is the case in all the different descriptions of timber.

ing fibres takes place. And hence we see that in the bending or fracture of any material, the particles on one side are dilated, whilst those on the other are compressed; and it will not be difficult to perceive, that there must be a line somewhere in the surface of the fracture, where neither extension nor compression is sustained.

13. If then in figure 3d, in which *adbc* is intended to represent the surface of fracture, *ab* be the neutral line, or that of which we have been speaking, and if *abd* be the surface of extension, and *acb* that of compression, it is evident that the extensions, or compressions of any particles, within those surfaces, will be as their distances from the line *ab*; and the forces necessary to produce them may be considered as in proportion to some powers v and w of those distances.

And in order to estimate the strength of the piece whose section is *acbd*, if F and f represent the points at which the forces, rising from extension and compression, being collected, would produce the same effects as they do at their respective distances from the neutral line: f will be the fulcrum on which all the horizontal forces may be conceived as sustained, and Ff one arm of a bended lever, while the length Gf is the

other, (the points F and G being supposed to be connected by the chain FG, merely to give the lever the appearance of greater strength.) And to obtain the strength of the body we shall have

$W \times fG =$ sum of the forces in $abd \times Ff$.

Whence $W = \frac{\text{sum of the forces in } abd \times Ff}{\text{the length } fG}$, where the deflection of the beam is neglected; or introducing that, as in art. 9, we have W (the weight) $= \frac{\text{sum of the forces in } abd \times (FP + Pf)}{\text{Length} \times \text{cosine of Deflection}}$

$= \frac{T \times D + T \times \Delta}{L \times C}$, where $T =$ sum of the forces rising from tension, D and Δ the distances of the centres of tension and compression from the neutral line, L the length of the piece, and C the cosine of its deflection.

14. A necessary consequence of this reasoning is, that the sums of the forces of extension and compression are just equal to one another:* For the weight W, acting in the di-

* The mode of reasoning adopted above has been objected to by Mr. Barlow, who conceives that the forces in F and f, or those of extension and compression, instead of being equal, should be inversely as their distances from the neutral line, or that the forces in $F \times PF =$ forces in $f \times Pf$, and that these taken collectively are $=$ the rectangle under the weight and the length of the beam, which is supposed to turn as on a pivot round the neutral line. Whence $L \times W =$ the forces in $F \times PF +$ forces in f

rection of GW, parallel to the surface of fracture *adbc*, can have no influence in pushing the piece toward or drawing it from the wall : and therefore the pressure on the fulcrum *f* must just be as great as the resistance in F, all the horizontal forces being supposed collected into those two points.

For the first outline of this subject, see the valuable treatise of Dr. Robison, referred to above.

15. Example. To find the strength of a rectangular beam, broke by a weight at the end as before ; the situation of the neutral line being given.

× P*f* = twice the forces in F × PF. The mode of estimating the strengths of bodies, as deduced from this, is very simple and easy ; it is in effect this :—Find the neutral line—suppose *that* the fulcrum—estimate the strength of the area of tension, as was done in incompressible bodies, and double that for the answer.

But this rule, it appears to me, contains within itself a fundamental error which will become very apparent by the following consideration.—It is supposed to be general whatever the situation of the neutral line may be. Let then the body be incompressible ; the neutral line will in that case be extremely near the edge, and the strength as estimated by this rule will be double what from incontestable principles it ought to be : a consequence which the ingenious author could have had no idea of when he proposed this theory. The error too will be found to exist, though in a less degree, in almost every other position of the neutral

Let ACBD (figure 4th) be the section of fracture, whose breadth is b, and depth d, and let a denote the distance of the neutral line AB from the top of the beam; then $d-a$ will be its distance from the bottom. Call any intermediate distance from AB, on the line of extension, as that of de, x; and any distance on the line of compression, as that of ɜ, y. Then (if we put $s =$ the weight sustained by a fibre at the top, and $r =$ the cotemporary resistance of one at the bottom, and v and $w =$ the powers of extension and compression, which are as their forces respectively,) we shall have, as before, $a^v : x^v :: s : \frac{sx^v}{a^v} =$ force exerted by a fibre at distance

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line, and may be very plainly seen if we estimate by this rule, the strengths of bodies that suffer a slight compression, and compare the results with the known strengths of the same bodies, if they had been wholly incompressible.

For example:—The strength of an incompressible joist, broke by a weight hung at one end, being $\frac{sba^2}{l(v+2)}$, (articles 4th and 9th,) where s is the longitudinal strength of the fibres in a unity of surface, b the breadth of the piece, a its depth, l its length, and v the index of extension: the strength of a compressible one according to Mr. Barlow will be $\frac{2sbd^2}{l(v+2)}$, where d is the depth of the area of tension, and the rest as before.

x from AB, and $\frac{sbx^v}{a^v}$ = force of all the particles in de, and this multiplied by x, gives $\frac{sbx^{v+1}}{a^v}$ = their effect, or the momentum of their cohesion from AB. By a similar mode of reasoning we shall have the repulsive force of the particles in $\frac{rby^w}{(d-a)^w}$, and $\frac{rby^{w+1}}{(d-a)^w}$ = their effect from AB as before.

Suppose $d=\frac{1}{8}a$ then $\frac{2sbd^2}{l(v+2)}=\frac{1}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{2}{8}a$ ..... $=\frac{4}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{3}{8}a$ ..... $=\frac{9}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{4}{8}a$ ..... $=\frac{16}{32}\times\frac{sba^2}{l(v\times 2)}$

$d=\frac{5}{8}a$ ..... $=\frac{25}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{6}{8}a$ ..... $=\frac{36}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{7}{8}a$ ..... $=\frac{49}{32}\times\frac{sba^2}{l(v+2)}$

$d=\frac{8}{8}a$ ..... $=\frac{64}{32}\times\frac{sba^2}{l(v+2)}$

The last three terms of which must be false, since they all give the strengths greater than $\frac{sba^2}{l(v+2)}$, which is that of the joist when every fibre is submitted to tension, and the preceding five terms (setting aside accidental coincidences)

And finding the sums of the four preceding quantities, by the method used in article 4th, we have—

Sum of the $\frac{sbx^v}{a^v} = \frac{sb}{a^v} \times (1^v + 2^v + 3^v \text{ \&c. to } a^v) =$

$\frac{sba^{v+1}}{a^v(v+1)} = \frac{sba}{v+1}$ = sum of the forces of tension = T in the foregoing rule, $\frac{T.D + T.\Delta}{L.C}$, (article 13.)

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must be erroneous too, since they lead in a regular progression to the last three.

Now as Mr. Barlow has offered no reasons against the theory in the text (further than that it does not agree with his own, which we have just been examining,) we see no cause why it should be rejected, especially since it seems to us to be every where consistent and just.

It may not be improper to mention that M. Coulomb, in his paper on this subject (Memoires presentés à l'Académie des Sciences, tom. 7) makes $L \times W =$ the forces in $F \times PF +$ the forces in $f \times Pf$, and endeavours to shew that the forces in F and f, or those of tension and compression are equal: The theory of Mr. Barlow then differs from that of the French philosopher in this last particular, but we conceive that the latter must be right;—the results from it are the same as from that in the text, though it is much less convenient in its use. We particularly refer the reader to the above paper of M. Coulomb, as he has given a very minute analysis of the transverse strain: and the reason why this matter has been so long overlooked, seems to be that both M. Coulomb and Dr. Robison have contented themselves by giving a bare outline of it.

Also sum of the $\frac{sbx^{v+1}}{a^v} = \frac{sb}{a^v} \times \left(\frac{v+1}{1} + \frac{v+1}{2} + \frac{v+1}{3}\right.$ &c. to $\left.a^{v+1}\right) = \frac{sba^{v+2}}{a^v(v+2)} = \frac{sba^2}{v+2}$ = sum of the forces × by their distances = T×D in the same rule.

Also sum of the $\frac{r\,b\,y^w}{(d-a)^w}$, by a similar process, $= \frac{rb\,(d-a)}{w+1}$ = the sum of the forces of compression.

Also sum of the $\frac{rby^{w+1}}{(d-a)^w}$ in like manner $= \frac{rb\,(d-a)^2}{w+2}$ = the sum of the products of those forces × their distances.

Now by the nature of the centre of gravity: The sum of the products of any forces × by their distances, divided by the sum of those forces, is equal to the distance at which if they were all collected they would produce the same effect. Hence $\frac{\frac{rb\,(d-a)^2}{w+2}}{\frac{rb\,(d-a)}{w+1}} = \frac{w+1}{w+2}(d-a) = \Delta$ in the preceding formula.

And the strength or $\frac{\text{T.D} + \text{T.}\Delta}{\text{L.C}} = \frac{\frac{sba^2}{v+2} + \frac{sba}{v+1} \times \frac{w+1}{w+2}(d-a)}{\text{L}\times\text{C}} = \frac{sba}{\text{L.C}}\left(\frac{a}{v+2} + \frac{w+1}{(v+1)(w+2)}(d-a)\right)$. And if a be taken in terms of d it will appear that the strength is as the square of the depth

Cor. 1st. If $v = w$, or the forces are as the same power of the extensions and compressions, strength $= \frac{sbad}{L \times C.(v+2)} = \frac{sd}{(v+2)L \times C} \times$ section of tension.

Cor. 2d. If $v = w = o$, strength $= \frac{sd}{2L.C} \times$ section of tension.

Cor. 3d. If $v = w = 1$, strength $= \frac{sd}{3L.C} \times$ section of tension.

16. And thus we might proceed to find the strengths of beams of other forms, as triangles, their frustums, &c. But to obtain that of any general form ABCD, figure 5th, it may be necessary to make use of fluxions; and if we call the depth of tension pc $= a$, any distance px $= x$, de $=$ X, depth of compression pf $= d$, any distance py $= y$, $\dot{s} = \dot{Y}$, the neutral line ab $= b$, and the rest as before, we shall then have the force exerted in de $= \frac{s\dot{X}x^v}{a^v}$, the breadth of de being unity, or the force $= \frac{s\dot{X}x^v\dot{x}}{a^v}$ when its breadth is $= \dot{x}$, (art. 9); and $\frac{s\dot{X}x^{v+1}\dot{x}}{a^v} =$ the product of the force in de when multiplied by the distance of the neutral line. And in the same manner the resistance in $\dot{s}_r = \frac{rY^w\dot{y}}{d^w}$, and $\frac{rY^{w+1}\dot{y}}{d^w} =$ the product as before.

And hence, in the foregoing formula $\frac{\text{T.D} \times \text{T.}\Delta}{\text{L C}}$, we have the

Sum of the forces in acb, or $\int^{s}\frac{sXx^{v}\dot{x}}{a^{v}} = \text{T}$, that of the products of the forces $\times$ their distances, or $\int^{s}\frac{sXx^{v+1}\dot{x}}{a^{v}} = \text{T.D}$,

and $\frac{\int^{r}\frac{rYy^{w+1}\dot{y}}{d^{w}}}{\int^{r}\frac{rYy^{w}\dot{y}}{d^{w}}} = \frac{\int Yy^{w+1}\dot{y}}{\int Yy^{w}\dot{y}} = \Delta.$

Whence the strength $= \frac{\int sXx^{v+1}\dot{x} + \int sXx^{v}\dot{x} \times \frac{\int Yy^{w+1}\dot{y}}{\int Yy^{w}\dot{y}}}{a^{v}\,\text{L.C}}$

(when $x = a$, and $y = d$). And this is a general expression for it when the situation of the neutral line is given.

Cor. 1st. If $v = w = o$,

strength $= \frac{\int sX\dot{x} + \int sX\dot{x} \times \frac{\int yY\dot{y}}{\int Y\dot{y}}}{\text{L.C}}$, and since $\int X\dot{x}$ and $\int Y\dot{y}$ are the sections of tension and compression, and $\int xX\dot{x}$, and $\int yY\dot{y}$, the areas of those sections multiplied by the distances of their centres of gravity, the strength becomes $= \frac{sg}{\text{L.C}} \times$ section of tension $+ \frac{s}{\text{L.C}} \times$ section of tension $\times \frac{g' \times \text{section of compression}}{\text{section of compression}} = \frac{s}{\text{L.C}} \times$ section tension $\times (g + g')$, where g and

g' are the distances of the centres of gravity of the sections of tension and compression respectively from the neutral line.

Cor. 2d. If $v = w = 1$,

$$\text{Strength} = \frac{f_{sx^2}X_{\dot{x}} + f_{sx}X_{\dot{x}} \times \frac{f_{y^2}Y_{\ddot{y}}}{f_yY_{\dot{y}}}}{aL.C}$$

(when $x = a$ and $y = d$) = (by corollary 2d, art. 9th, and the last corollary above) $\frac{sgp}{aL.C} \times$ section of tension $+ \frac{sg}{aL.C} \times$ section of tension $\times \frac{p'g' \times \text{section compression}}{g' \times \text{section compression}} = \frac{sg}{aL.C} \times$ section of tension $\times (p+p')$, where p and p' are the distances of the centres of percussion of the surfaces of tension and compression from the neutral line, and g and g', as before.

17. Example. Let the surface of fracture ABCD, (fig. 5th,) be the segment of a triangle, whose base is CD and vertex E; the part ABba being that of tension. Call pE, the distance of the neutral line from the vertex, $= h$, and the rest as before: And to express pc and pf, or the depths of the surfaces of tension and compression, in terms of h, let m and n be such numbers that a or pc may be designated by mh, and d or pf by nh. Then by similar triangles Ep : ab :: Ex : de. In symbols $h : b :: h-x : \frac{b}{h}(h-x) = de = X$. And in like manner $h : b :: h+y : \frac{b}{h}(h+y) = \frac{b}{h} =$

Y. And these values of a, X, and Y, substituted in the foregoing general expression (art. 16,) give the strength

$$= \frac{\int \frac{sb}{h}(hx^{v+1} - x^{v+2})\dot{x} + \int \frac{sb}{h}(hx^{v} - x^{v+1})\dot{x} \times}{m^v h^v \text{L.C}}$$

$$\frac{\int \frac{b}{h}(hy^{w+1} + y^{w+2})\dot{y}}{\int \frac{b}{h}(hy^{w} + y^{w+1})\dot{y}} = \text{(finding the fluents and}$$

dividing), $\frac{sb}{m^v h^{v+1} \text{L.C}}\left(\left(\frac{hx^{v+2}}{v+2} - \frac{x^{v+3}}{v+3}\right) + \left(\frac{hx^{v+1}}{v+1} - \frac{x^{v+2}}{v+2}\right) \times \frac{\frac{hy^{w+2}}{w+2} + \frac{y^{w+3}}{w+3}}{\frac{hy^{w+1}}{w+1} + \frac{y^{w+2}}{w+2}}\right)$, which, when $x = mh$ and $y = nh$, becomes $\frac{sbh^2}{\text{L.C}} \times$

$$\left(\left(\frac{m^2}{v+2} - \frac{m^3}{v+3}\right) + \left(\frac{m}{v+1} - \frac{m^2}{v+2}\right) \times \frac{\frac{n}{w+2} + \frac{n^2}{w+3}}{\frac{1}{w+1} + \frac{n}{w+2}}\right),$$

a general expression for the strength of the frustum ABCD.

18. When $mh = h$, or $m = 1$, we have the strength $= \frac{sbh^2}{\text{L.C}} \times$

$$\left(\left(\frac{1}{v+2} - \frac{1}{v+3}\right) + \left(\frac{1}{v+1} - \frac{1}{v+2}\right) \times \frac{\frac{n}{w+2} + \frac{n^2}{w+3}}{\frac{1}{w+1} + \frac{n}{w+2}}\right),$$

which is that of the whole triangle. But in this case the situation of the neutral line ab,

together with the values b, h and n dependent on it, is changed, and must first be determined.

Cor. When nh, the depth of the surface of compression is indefinitely small, n being then $= o$, the fulcrum is on the edge, and the strength of the triangle becomes $\frac{sbh^2}{\text{L.C}}\left(\frac{1}{v+2} - \frac{1}{v+3}\right)$, as in article 6th.

We might in one of the preceding examples have put the sum of the forces of tension equal to those of compression, and thence, the neutral line being supposed given, have determined the ratio of s to r, and from that the ratio of the forces necessary to produce a given extension and compression in a fibre, which ratio must be constant in the same kind of body for any given extension or compression.

We shall not however seek for that ratio, but suppose it known, and make it the subject of a problem. But we will first give the following lemma.

19. Lemma. In the bending of any body, this proportion will obtain: as the extension of the outer fibre on one side is to the contraction of that on the other, so is the distance of the former from the neutral line to that of the latter.

Demonstration. Let kl (fig 6th,) be an imaginary line perpendicular to the upper

side of the beam, hi another line perpendicular to the side at h, and which, before flexure coincided with kl; hm and km will then be the increments of the outer fibre at h and k, and equal to one another. In the same manner ln and in will be the corresponding decrements, which will likewise be equal, and p the situation of the neutral line. But hm and km will be parallel to in and ln respectively, and hence the quadrilaterals hmkp and inlp are similar: we have then on that account mp : pn : : hm + mk : ln + ni, which is as the extension to the compression.

In the actual bending of a body, its flexure is made up of an infinite number of these angles hpk, lpi, each indefinitely small. Their supplements therefore, or the angles hmk and lni will each be indefinitely near to two right angles; and the indefinitely small extensions and compressions hmk and lni may be taken as straight lines; which we shall do in the following problem.

20. To find the position of the neutral line: The ratio of the forces necessary to produce an equal extension and compression in a fibre being given, as s to c; and the alteration in its length in consequence of s or c being assumed unity.

Since the sum of the forces of extension

are equal to those of compression (art. 14,) we have

$\int \frac{^{v}sXx^{v}\dot{x}}{a^{v}} = \int \frac{^{w}rYy^{w}\dot{y}}{d^{w}}$ (when $x = a$, and $y = d$), s being the resistance of the most extended fibre, and r that of the most compressed. If then, in figure 6th, hk be unity, s will be the force necessary to produce the extension hk, and r the resistance answering to the compression li. Now by the lemma mp : pn :: hk : $\frac{pn \times hk}{mp}$ = li : Hence li = $\frac{d}{a}$, putting a for mp, d for pn, and hk being unity. And since the forces are as the w power of the compression of a fibre, and the compression caused by c = unity, we have $1^{w} : c :: \left(\frac{d}{a}\right)^{w} : \frac{cd^{w}}{a^{w}}$ which is a new value of r; and this substituted for r, in the equation of the forces above, gives $\int \frac{^{v}sXx^{v}\dot{x}}{a^{v}} = \int \frac{^{w}cYy^{w}\dot{y}}{a^{w}}$.

Cor. 1. If $v = w = o$, or all the forces are constant

$\int \frac{^{o}sXx^{o}\dot{x}}{a^{o}} = s \times \int X\dot{x} =$ $s\times$ section of tension,

and $\int \frac{^{o}cYy^{o}\dot{y}}{a^{o}} =$ $c \times \int Y\dot{y} = c\times$ section of compression.

But these quantities are equal, and therefore section of tension : section of compression : : c : s, a constant ratio, determinable by experiments.

Cor. 2d. If $v = w = 1$, or the forces are as the extensions and compressions. $f\frac{sXx^v\dot{x}}{a^v} = \frac{s}{a} \times f\, xX\dot{x} = \frac{s}{a} \times$ section of tension $\times\, g$, where g is the distance of the centre of gravity of that section from the neutral line. And $f\frac{cYy^w\dot{y}}{a^w} = \frac{c}{a} \times f\, yY\dot{y} = \frac{c}{a} \times$ section of compression $\times\, g'$, g' being the distance of *its* centre of gravity as before. Hence $\frac{s}{a} \times$ section of tension $\times\, g = \frac{c}{a} \times$ section of compression $\times\, g'$; $\therefore$ section of tension $\times\, g$: section of compression $\times\, g' :: c : s$,* a constant

* From the application of those principles which we have controverted in the preceding note, Mr. Barlow has obtained a rule for finding the position of the neutral line when the centres of tension and compression coincide with those of gravity, and which is the same as the second corollary. But in Mr. B.'s case v and w in the text are each $= o$; and if what we have done there be correct, the surfaces, (not the surfaces multiplied by the distances of their centres of gravity,) must be in a constant ratio, as in Cor. 1st.

It may further be stated, that the very disputable conclusions which that gentleman has arrived at of the effect being the same as if all the fibres resisted with equal forces (or that the centres of tension and compression are the same as the centres of gravity of the sections) seem wholly to rise from the false theory which he has adopted since they were derived from the application of that theory.

ratio as before: or that of the compression to the extension of the external fibres (since the compressions and extensions are here as the forces,) and as the ratio remains the same for any other degree of flexure, the neutral line must, under the conditions of this corrollary, be fixt.

PART II.—*Experimental.*

21. In the preceding investigations, the theorems, and calculations dependant on them, are given in general terms, and seem to include all the conditions that can well be introduced into inquiries of this nature. But before they can be applied to practice, it will be necessary to determine, by experiments, the values of some of the quantities which compose them, as v, w, a, &c. where v is the power of the extension on which the force depends; w is that of the compression, which is in proportion to the power exerted to produce it; and a is the distance of the neutral line from the extremity of the dilated fibres in the surface of fracture.

EXTENSION.

22. We will first then spend a few moments in considering the subject of extension; and as a number of experiments have

been made on it by different philosophers, from Mariotte down to our own times, and they have generally agreed, when properly conducted, in giving moderate extensions proportional to the extending forces, we can scarcely doubt that it is a law of cohesion.

An experiment or two by Dr. Robison it may not be useless to quote. He says, "We made experiments on fine slips of gum caoutchouk, and on the juice of the berries of the white bryony, of which a single grain will draw to a thread of two feet long, and again return to a perfectly round sphere. We measured the diameter of the thread by a microscope, with a micrometer, and thus could tell in every state of extension the proportional number of fibres in the sections. We found that though the whole range in which the distance of the particles was changed (varied) in the proportion of 13 to 1, the extensions did not sensibly deviate from the proportion of the forces."

"The same thing was observed in the caoutchouk, as long as it perfectly recovered its first dimensions. And it is," continues the Doctor, "on the authority of these experiments that we presume to announce this as a law of nature."

It appears to me that such experiments as these shew very satisfactorily the law that regulates the actions of the particles upon one another: But whether the same conclusion would be drawn from stretching the fibres of so irregular a thing as a piece of timber, and especially when near their fracture, is not quite so plain. We have scarcely any means of doing that but by bending it; and then, if we fasten one end of a beam firmly in a wall, and hang weights at the other, the strain will be complex: the piece will be subject to extensions and compressions the laws of which may change, together with the situation of the neutral line; and the only conclusion we can draw is, that the aggregate of the extensions and compressions it sustains, leaves a deflection from its primitive form, which is nearly in proportion to the force.

23. But it occurred to me, that if we could prevent compression taking place by furnishing an artificial fulcrum on the side of the beam, we should by bending it have all its fibres in a state of dilatation, and that in proportion to their distance from the fulcrum.

With this intention we took two pieces of iron, each one inch broad, $\frac{1}{8}$th inch thick, and from a foot to 18 inches long. The end of one of them was sharpened a little to fit

into a groove formed in the end of the other: With these two ends brought into close contact, the irons were firmly nailed to one side of the piece of wood intended to be operated upon, the junction of the irons being at its middle. The piece of wood, having that side with the iron on it uppermost, was then laid horizontal, with its ends resting on two props, and weights were hung at its middle, while the point of a needle which was fixt to the wood indicated on an ivory scale, the quantities of its depressions.

EXPERIMENTS.

The first was on a slip of yellow Pine, one inch square, and two feet seven inches between the props.

RESULTS.

Weights in Pounds.	Deflections in parts of an Inch.	When Weights taken off returned to.	Arithmetical Progression, whose common difference is five.	Variations.
15	.05	0	4	+ 1
30	.08	0	9	— 1
45	.12	0	14	— 2
60	.19	0	19	0
75	.25	0	24	+ 1
90	.29	0	29	0
105	.34	0	34	0
120	.37	Perceptible Deflection.	39	— 2
135	.41		44	— 3
150	.45		49	— 4
165	.57	.10	54	+ 3
180	.64	„	59	+ 5
195	.70	„	64	+ 6
210	.73	„	69	+ 4
225	.78	„	74	+ 4
240	.83	.17	79	+ 4

The next piece was of Baltic Fir; it was one inch deep, half inch broad, and two feet three inches between the supports.

THE RESULTS WERE

Weights in Pounds.	Deflections in parts of an Inch.	When Weights taken off returned to.	Arithmetical Prog. common diff. three.	Variations.
15	.05	0	5	0
30	.08	0	8	0
45	.12	0	11	+1
60	.14	0	14	0
75	.17	0	17	0
90	.20	0	20	0
105	.235	0	23	+½
120	.26	0	26	0
135	.28	+	29	−1
150	.30	+	32	−2
165	.35	.02	35	0
180	.38	.04	38	0
195	.40	.07	41	−1
210	.44	.07	44	0
225	.46	„	47	−1
240	.48	„	50	−2
255	.50	„	53	−3
270	.53	about .13	56	−3

In another experiment, which was one of the most anomalous we made, and in which one end of the piece was fixt, and the weights hung at the other, the results were as follow.

Weights.	Deflections.	Weights.	Deflections.
5	8	60	98
10	15	65	109
15	21	70	120
20	28	75	133
25	34	80	146
30	41	85	163
35	51	90	177
40	61	95	195
45	70	100	222
50	79	105	241
55	87	110	It bore this about ½ a minute, and then broke.

The two first of these experiments are the concluding ones of a series of a similar kind, and were made with great care. Previous to their commencement, a considerable weight, but still such as would not injure the elasticity of the wood, was laid upon it, to make the iron recede as much as possible. The weight

was then taken off, and a small slip of thin tin forced in between the ends of the iron.

24. The deflections in both of them and consequently the extensions are, through their whole ranges, very nearly in the proportion of the forces. The same may be said of the last experiment, and of every other we made, during the earlier stages of flexure; but as we continued the experiment, and arrived nearer to fracture, the extensions always increased faster than the forces.—We will seek for the ultimate value of the index v in the last experiment, and for that purpose shall select one of the earlier weights, as 20lb, with its deflection 28, and the last weight it bore or 105lb, with its deflection 241; and since the forces were supposed to be as the v power of the extensions, we have $20^{lb} : (28)^v :: 105^{lb} : (241)^v$. But v in the two cases is different, and in the former is $= 1$ (since then the extensions were as the forces), and hence we have $20 : 28 :: 105 : (241)^v$, or $(241)^v = \frac{28 \times 105}{20} = 147$. And by taking the Logarithms we have $v \times$ Log. $241 =$ Log. 147, and $v = \frac{\text{Log. } 147}{\text{Log. } 241} = \frac{2.1673173}{2.3820170} = \frac{9098}{10000} = .91$ nearly.

And pursuing the same mode with respect to the two former experiments, and considering

the tabular deflections as integers, since the result will be the same, we shall have—

In the first,

$60\text{lb} : 19 :: 240\text{lb} : (83)^v = \frac{19 \times 240}{60} = 76$. Whence $v = \frac{\text{Log. } 76}{\text{Log. } 83} = \frac{1.8808136}{1.9190781} = .98$.

In the second,

$90 : 20 :: 270 : (53)^v = 60 \therefore v = \frac{\text{Log. } 60}{\text{Log. } 53} = \frac{1.7781512}{1.7242759} = 1.03$.

25. And taking the mean, we have $\frac{.98 + 1.03 + .91}{3} = .97 =$ ultimate mean value of v. A number which so nearly approaches to unity, the index of perfect elasticity, that it seems unnecessary to assume any other law.

COMPRESSION.

26. The next subject of our inquiry is compression; or the contractions which the fibres of a piece of timber would sustain by forces applied in the direction of their length. And as this subject does not appear to have been much attended to by others, we trust it will plead our excuse if we give a detail of a greater number of experiments, than we otherwise should do of our own.

What we have done in this matter was in pursuance of a similar idea to that we used in our last, only with this exception, that there we employed the iron to prevent compression

of the fibres, and here we have done it to prevent their extension, in order that we might have their compression alone.

For this purpose we took two pieces of iron of the same general breadth and thickness as before, and whose form is that of figure 7th.

These irons were firmly nailed or screwed to the piece of wood intended to be operated on as before, omitting the nails between B and C, and leaving the irons at the joint AB a small distance asunder, and held at that distance by two links A and B sliding upon the ends of the irons. The wood, with the iron under it, was then laid between two props, and a weight hung at its middle C to make the irons move as much as possible. The weight was then taken off, and the irons rendered very tight by means of the two links: This done, the irons being considered perfectly firm, we nailed the part between B and C, and commenced the experiments. But before we give an account of these, it may be well to state that, at the point C, which was equidistant from the ends of the wood, the iron was flattened and drawn out to nearly double the breadth, and only half the thickness, so as to increase its flexibility without diminishing its strength.

EXPERIMENTS.

Yellow Pine; each piece one inch square, and two feet seven inches between the supports.

Weights.	Deflections in parts of an Inch.			
	1st. *Piece.*	2d *Piece.*	3d *Piece.*	
15lbs	.04	.04	.03	
30	.08	.08	.06	
45	.12	.13	.09	
60	.16	.16	.12	
75	.22	.22	.15	
90	.27	.26	.18	
105	.31	.31	.22	
120	.35	.35	.26	
135	.39	.40	.30	
150	.44	.44	.35	
165	.48	.50	.43	
180	.51	.55	.50	
195		.63	.58	
210			.68	
225			.93	Crippled.

Pine as before, one inch deep, half inch broad, and two feet six inches between the supports.

Weights.	Deflections in parts of an Inch.	When Weights taken off returned to.	Progression.
5lb.	.02	0	.015
10	.035	0	.030
15	.04	.01	.045
20	.055	.01	.060
25	.07	.01	.075
30	.09	.01	.090
35	.11	.015	.105
40	.13	.02	.120
45	.14	.02	.135
50	.16	.02	.150
55	.18	.02	.165
60	.20	.02	.180
65	.23	.03	
70	.265	.04	
75	.28	.05	
80	.325	.06	
85	.37	.07	
90	uncertain		
95	.44	.11	
100	.47	.11	
105	.52	.14	
110	.59	.17	
115	.75	.26	
120	.90 Crippled perceptably within less than $\frac{1}{10}$ through.		

Pine, one inch deep, half inch broad, and two feet three inches between the props.

Weights in Pounds.	Deflections, ¼ inch Scale.	Returned to.	Progression, common dif. nine.		Variations.
5	.08	0	8		0
10	.17	.01	17		0
15	.26	.04	26		— 1
20	.35	.07	35		0
25	.45	.09	44		+ 1
30	.54	.11	53		+ 1
35	.63	.14	62		+ 1
40	.73	.16	71		+ 2
45	.78	.19	80		— 2
50	.86	.20	89		— 3
55	.94	.21	98		— 4
60	1.02	.24	107		— 5
65	1.14	.25	116		— 2
70	1.18	.28	118	Ratio of 10	0
75	1.28	.30	128		0
80	1.38	.31	138		0
85	1.46	.32	148		— 2
90	1.58	.36	158		0
95	1.68	.38	168		0
100	1.80	.42	178		+ 2
105	It ran down to 2.10	.58			
110	2.20	.64			
115	Do. 2.50	.90			
120	perhaps 3.80	1.65	Crippled in two places.		

27. These few are selected from among a considerably greater number of experiments; but as the rest are tolerably well in accord with these, it may not be worth while to give any more. The natural inference from them is this: That so long as the forces are moderate, and are applied in the direction of the fibres, the compressions will be nearly as the forces: but when the beam becomes bent, the fibres being then crushed together as well incurvated, offer a feebler resistance to the force.

To find then the ultimate value of the index w, we shall follow the reasoning adopted under the article extension; and since the forces are supposed to be as (compression)^w, and the early value of w is found to be unity, we shall have:

In the first experiment (taking any early weight, as 30, with its compression 8, the deflections being considered integers, as in art. 24)

$$30 : 8 :: 180 : (51)^w = \frac{8 \times 180}{30} = 48. \therefore w \times \text{Log. } 51 = \text{Log. } 48, \text{ and } w = \frac{\text{Log. } 48}{\text{Log. } 51} = \frac{1.6812412}{1.7075702} = .984.$$

In the second experiment,

$$30 : 8 :: 195 : (63)^w = \frac{8 \times 195}{30} = 52. \therefore w = \frac{\text{Log. } 52}{\text{Log. } 63} = \frac{1.7160033}{1.7993405} = .953.$$

In the third experiment,

$45 : 9 :: 225 : (93)^w = 45.$ $\therefore$ $w = \frac{\text{Log. } 45}{\text{Log. } 93} = .840.$

In the fourth,

$30 : 9 :: 120 : (90)^w = 36.$ $\therefore$ $w = \frac{\text{Log. } 36}{\text{Log. } 90} = .798.$

In the fifth,

$20 : 35 :: 120 : (380)^w = 210.$ $\therefore$ $w = \frac{\text{Log. } 210}{\text{Log. } 380} = .901.$

28. And the mean of these ultimate values of w is $= \frac{.984+.953+.840+.798+.901}{5} = .895.$*

29. By the same reasoning too we found the mean value of w in these experiments, when the weights were $\frac{1}{4}$ those of fracture $= \frac{.97+.97+.92+.88+1.00}{9} = .95$ nearly, which may with very trifling error be assumed unity.

30. But it was suggested to me by Mr. Dalton, that the iron might possibly be dilated or contracted to such a degree in these experiments, as to render it necessary to correct them.

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* The reader will easily perceive that the above ultimate value of w, and that of v in article 25th, can, strictly speaking, apply to no other form of beam but that of a joist; they are nevertheless of considerable importance, and will enable us to form an idea of the quantity of the error which would arise from supposing the extensions and compressions to be as the forces.—*See Exam. 3rd. Art. 34th.*

With this view I took a piece of iron wire, 7 feet long, and weighing 2 dwts. 17 grs. and hanging a two pound weight to it to render it perfectly straight, noted its extensions in parts of an inch, which are as follow:

With 10lbs. it stretched .07
20 ..... .16
30 ..... .26. It returned, when the 30lb was taken off, to .03, and broke with 35lbs.

Another similar wire stretched .26 inch with 30lbs, and broke with 35lbs. This wire, like the former, weighed 2 dwts. 17 grs.

I then compared the strength of the iron I used with that of the wire, and found the former about 319 times as strong as the latter. And as not more than 3 inches of the iron was subjected to uninterrupted extension, the error, from the dilatation of the iron, could not, in any of the experiments we have given, have influenced the deflections as much as $\frac{1}{300}$ part of an inch, and in the two last must have affected them less than $\frac{1}{700}$.

The mode of calculation we used, was to find the effect of a weight equal to $\frac{1}{4}$ the greatest we made use of, upon the end of a lever, one arm of which was = half the greatest distance between the props, and the other arm $\frac{3}{5}$ds of an inch = the distance of the cen-

tre of the forces exerted by the fibres from the fulcrum or iron.—But the process is omitted as uninteresting.

It will then be unnecessary to use any correction for the dilatation of the iron in *these experiments;* and as it is improbable that its compressions will be much greater than its dilatations from equal forces, it will be unnecessary too to correct for what compression it may have sustained in the *former.*

NEUTRAL LINE.

31. My next object was to find the position of the neutral line, and that before the piece was overstrained, since then the extensions and compressions are nearly as the forces. With this intention I formed an arc of a circle, the greatest a piece of yellow pine one inch deep would bear without destroying its elasticity, and, bending upon it the pieces of wood intended to be operated on, obtained by admeasurement the extensions of the outer sides, and the contractions sustained by the inner ones.

The method I used was this: I took a slip of tin upwards of 9 feet long, and whose thickness was not more than $\frac{1}{60}$th or $\frac{1}{70}$th of an inch. It had one end divided into parts of an inch, and the other nailed to the ex-

tremity of the piece of wood on which the experiment was to be made, and was constantly stretched by one considerable weight. The piece of wood with the tin at its side was then made perfectly straight, and its length was obtained by noticing with great care, what division on the graduated extremity of the tin, corresponded with a point at the loose end of the wood. The piece was then bent on the curve above described, and the length of the side to which the tin was nailed, (whether the side was extended or contracted) taken as before. The tin closely touched the side of the wood in every part, and hence served as a fair measure of its length, and the difference of the two measures just described, must give the increment or decrement of the side: to obtain which, the results of our experiments are as under:

Yellow Pine, each piece nine feet long, and one inch deep.

	Inch.
First Expt.—Increment of the outer fibre.....	.215
Do. when piece reversed, or when the side which was first contracted became extended...	.210
Mean increment.....	.2125
Decrement of the inner fibre, or contraction of that side	.240

Second Expt.—Increment of the outer fibre..... .210
Do. when side reversed, as above .210

Mean increment..... .210

Decrement of inner fibre..... .235

After the experiments there was a deflection in the pieces of about $\frac{1}{5}$ inch.

Dantzic Fir, two slips, each nine feet long, and one inch deep.

Inch.

First Slip.—Increment of outer fibre, mean of two experiments ..... .230
Do. of the other side ..... .235

Mean extension..... .2325

Decrement of the inner fibre..... .250

Second Slip.—Increment of one side..... .235
Do. of the other..... .220

Mean increment..... .2275

Decrement of one side..... .245
Do. of the other..... .255

Mean decrement..... .250

Depth of set after these experiments about $\frac{1}{4}$ inch.

Quebec Oak, two slips, each eight feet ten inches long, and one inch deep.

	Inch.
First Slip.—Increment of one side.....	.200
Do. of the other	.220
Mean increment.....	.210
Decrement of side last measured	.245
Do. of the other	.240
Mean decrement	.2425

	Inch.
Second Slip.—Increment of one side.....	.215
Do. of the other	.220
Mean increment.....	.2175
Decrement of last measured side	.245
Do. of the other.....	.235
Mean decrement.....	.240

After these experiments the pieces had taken a set in either direction, the depth of which was about $1\frac{1}{4}$ inch.

Another piece, same kind of wood, eight feet ten inches long, and $1\frac{1}{4}$ *inches deep.*

	Inch.
Increment of one side	.250
Do. of the other.....	.255
Mean increment.....	.2525
Decrement of last measured side..	.285
Do. of the other side.....	.300
Mean decrement.....	.2925

Before the experiment this piece was bent about an inch, and the first trial gave it a set of nearly the same quantity on the opposite side, but the second left it bent upwards of two inches in its original direction; which changes it afterwards followed.

32. In the preceding experiments, I have endeavoured to obtain, to the best of my power, the exact extensions and compressions sustained by the sides of the pieces I used; and it will appear by the lemma, (art. 19,) that those extensions and compressions are as the distances of the neutral line from the sides to which they belong. The areas of tension and compression would then be in that proportion, since the pieces we made use of were all rectangular.

If therefore we select from above the mean results, we shall have, in rectangular pieces, before the timber is much overstrained, the depth or area of tension to that of compression—

In Yellow Pine,

From 1st experiment, as 212½ to 240
2nd..... 210 to 235

Mean ratio 169 to 190

In Dantzic Fir,

From 1st experiment, as 232½ to 250
2nd..... 227½ to 250*

Mean ratio 23 to 25

In Quebec Oak,

From 1st experiment, as 210 to 242½
2nd..... 217½ to 240
3rd..... 252½ to 292½

Mean ratio 27 to 31

33. The situation of the neutral line in a joist being known, we shall be enabled to find from that its position in beams of other forms; for since in all moderate strains the extensions and compressions are nearly as the forces, we have (from Cor. 2, Art. 20) section of tension $\times g$: section compression $\times g'$ :: c : s, a constant ratio.—And hence this general rule—

Divide the surface of fracture into two such parts that the section of tension, multiplied by the distance of its centre of gravity

* Mr. Barlow found that the area of tension to that of compression in rectangular fir beams was nearly as 3 to 5, which is a considerably greater compression than that given above; but our experiments were made during moderate strains, and his at the time of fracture. Admitting both to be correct, it possibly may be accounted for by the tendency that soft woods have to cripple when over compressed.

from the neutral line, may be to the section of compression multiplied by the distance of *its* centre of gravity from the same line, in the ratio obtained from the joist; and which, in pine, will be nearly as 4 to 5.

The ratio will be obtained thus—From the mean of our experiments on that wood, the depth of the section of tension to that of compression in a joist was as 169 to 190. Call these numbers the absolute depths of the sections, and if the breadth of the piece be supposed unity, they will represent the areas likewise; and their halves, or $\frac{169}{2}$ and $\frac{190}{2}$, will be the distances of the centres of gravity of the respective sections from the neutral line. The ratio sought will therefore be expressed by $169 \times \frac{169}{2}$ to $190 \times \frac{190}{2}$, or by $(169)^2$ to $(190)^2$, which is as 79 to 100, or as 4 to 5 nearly.

In like manner, since we found the mean depth of the section of tension to that of compression in Dantzic fir as 23 to 25, the ratio above will be $(23)^2$ to $(25)^2$, or as 17 to 20 nearly.

The mean of our experiments on Quebec oak gave 27 to 31, the ratio above will then be $(27)^2$ to $(31)^2$, or 729 to 961, which is nearly as 3 to 4.

The mean from all these is 4 to 5, as found for pine.

And to divide any surface ABCD, (fig. 8) as required above: Let EFCD and EFBA be the sections of tension and compression respectively, and G and g their centres of gravity. We shall then have EFCD × iG : EFBA × ig in a given ratio, which we will call m to n. But since, by the Centrobaryc Method, the solid, formed by the revolution of any surface, as EFCD, round EF, is equal to the area of that surface multiplied by the distance passed over by its centre of gravity, or equal EFCD × iG × $2p$, (where p is $= 3.1416$); we have then, solid formed by revolution of EFCD : solid formed by revolution of EFBA (round EF) :: EFCD × iG × $2p$: EFBA × ig × $2p$ :: EFCD × iG : EFBA × ig :: m : n. The solids formed by the revolution of the sections round the neutral line are therefore in the given ratio; and this must be the case whatever be the form of the beam.

Example. Let it be required to find the situation of the neutral line in a beam, the form of which is the frustum ABCD (fig. 8) of an isosceles triangle, whose top DCH has been cut off parallel to AB.

Call Hk, the height of the triangle, $= a$,

hk, that of the frustum, $= d$,

AB, the base, $= b$,

hi, the distance of the neutral line from the top $= x$,

The solid formed by the revolution of EFCD round EF $= S$,

Solid formed by revolution of EFBA round EF $= S'$,

and the rest as before.

We have then Hk : AB :: Hi : EF

or $a : b :: a-d+x : \frac{b}{a}(a-d+x) = \text{EF}$.

And Hk : AB :: Hh : DC

or $a : b :: a-d : \frac{b}{a}(a-d) = \text{DC}$.

Whence $\text{El} = \frac{1}{2}(\text{EF}-\text{DC}) = \frac{1}{2}\left(\frac{b}{a}(a-d+x) - \frac{b}{a}(a-d)\right) = \frac{bx}{2a}$; and $\text{nE} = \frac{1}{2}(\text{AB}-\text{EF}) = \frac{1}{2}\left(b - \frac{b}{a}(a-d+x)\right) = \frac{b}{2a}(d-x)$, Dl and nA being parallel to Hk.

But S is = a cylinder whose length is lm (= DC) and the radius of whose base is hi, + twice the content of a cone formed by the triangle ElD revolving round El. Now, by Mensuration, the content of the cylinder is $= p \times (\text{Dl})^2 \times \text{lm} = px^2 \times \frac{b}{a}(a-d) = \frac{pb(a-d)x^2}{a}$; and that of the cone is $= p\,(\text{Dl})^2 \times \frac{1}{3}\,\text{El} = px^2 \times \frac{1}{3} \times \frac{bx}{2a} = \frac{pbx^3}{6a}$; S, therefore $= \frac{pb(a-d)x^2}{a} + \frac{pbx^3}{3a} = \frac{pb}{a}\left((a-d)x^2 + \frac{x^3}{3}\right)$.

In like manner S' = a cylinder whose length is AB and the radius of whose base is

ik,—double the content of a cone formed by the triangle AEn revolving round En.

And since a cylinder on AB is $= p(\mathrm{ik})^2 \times \mathrm{AB} = p(d-x)^2 b$; and the cone on nE $= \frac{1}{3} p(\mathrm{ik})^2 \times \mathrm{nE} = \frac{p}{3}(d-x)^2 \times \frac{b}{2a}(d-x) = \frac{pb}{6a}(d-x)^3$, we have $S' = p(d-x)^2 b - \frac{pb}{3a}(d-x)^3 = pb\left((d-x)^2 - \frac{(d-x)^3}{3a}\right)$.

But $S : S' :: m : n$.

Therefore $\frac{pb}{a}\left((a-d)x^2 + \frac{x^3}{3}\right) : pb\left((d-x)^2 - \frac{(d-x)^3}{3a}\right) :: m : n$. Hence $\frac{npb}{a}\left((a-d)x^2 + \frac{x^3}{3}\right) = mpb\left((d-x)^2 - \frac{(d-x)^3}{3a}\right)$, and dividing by $\frac{pb}{3a}$ we have $3n(a-d)x^2 + nx^3 = 3ma(d-x)^2 - m(d-x)^3$; whence by involution, &c. we get

$$x^3 + 3(a-d)x^2 + \frac{3md}{n-m}(2a-d)x = \frac{md^2}{n-m}(3a-d);$$

a cubic equation from which the value of x may be obtained: and which is independent of the breadth of the beam.

Suppose for example a and d are 9 and 8 inches respectively, and m to n is as 4 to 5; which is the mean ratio obtained from our experiments.

Then the equation above becomes

$$x^3 + 3x^2 + 960x = 4864.$$

Whence $x = 4.872025$ nearly.

Cor. If $d=a$, the equation for the whole triangle becomes $x^3 + 972\ x = 5832$. Whence $x = 5.799337$, which is the distance of the neutral line from the vertex.*

34. The situation of the neutral line having been determined by the foregoing rule, or by direct experiment, the strength of the piece may be obtained by the following formula $\frac{sgA\ (p+p')}{aL.C}$ (Art. 16th, Cor. 2d,) where s is the direct longitudinal strength of the fibres contained in a unity of surface; A the area of the section of tension, a its depth, g the distance of its centre of gravity from the neutral line, p and p' the distances of the centres of percussion of the sections of tension and compression respectively, L the length of the piece, and C the cosine of its deflection. —But when the flexure is moderate C may be omitted without much error, and we will do so in the following examples.

Example 1st. Required the strength of a joist of Dantzic fir, nine feet long, one foot deep, and three inches broad, the weight being applied at its end?

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* The above example, as well as some other parts in the conclusion of this paper, have been added by permission, since the paper was read.

The direct strength of a square inch of fir, according to Muschenbroek, is 8330 pounds, which above is denominated s; and the depth of the surface of tension being to that of compression as 23 to 25 (art. 32): In order to find the neutral line we have, $23+25$: 23 :: 12 (the depth) : $\frac{23\times12}{23+25}=5{\cdot}75$ inches $=a$, the depth of tension. $\therefore g=\frac{5{\cdot}75}{2}$; $p=\frac{2}{3}\times5{\cdot}75$, and $p'=\frac{1}{3}(12-5{\cdot}75)$, by the properties of the centres of gravity and percussion. $\therefore p+p'=\frac{2}{3}\times12$ (the whole depth) $=8$ inches. Hence the formula for the strength $\frac{sgA(p+p')}{aL}$ becomes

$$\frac{8330\times\frac{5{\cdot}75}{2}\times5{\cdot}75\times3\times8}{5{\cdot}75\times108}=5322 \text{ pounds nearly.}$$

Example 2d. What weight must be suspended from the middle of a beam of Quebec oak to cause a tension in its lowest fibres of 8000 pounds to the inch, the beam being 20 feet long and one foot square, and supported on a wall at each end?

Here s is 8000; and since half the weight is supported by each wall, it is evident that, if we suppose the beam fixt firmly at its middle, and then seek for the resistance at one end necessary to produce the given tension on its side, the double of that would be the

answer.—The depth of the extended surface being then to that of the compressed from a mean of our experiments on oak, as 27 to 31, or as 7 to 8 nearly, we have $7+8 : 7 :: 12$ (the depth) : $\frac{7\times 12}{7+8} = 5.6$ inches $= a$; $\therefore$ A $= 5{\cdot}6 \times 12 = 67.2$; $g = \frac{5{\cdot}6}{2}$; $p+p' = \frac{2}{3}\times 12 = 8$, and $L = \frac{20}{2} = 10$ feet $= 120$ inches; and the formula $\frac{sgA\times(p+p')}{aL}$ becomes $\frac{8000\times\frac{5{\cdot}6}{2}\times 67.2\times 8}{5.6\times 120} =$ 17920 pounds $=$ the pressure at the end; and $17920\times 2 = 35840$ pounds $=$ the weight at its middle.

Remark.—These two questions would have been solved with greater simplicity by Cor. 3d, art. 15th, but it was preferred to give them as examples to the more general theorem above.

Example 3d. Supposing 8000 pounds to the inch to be the full direct cohesion of the piece, and the position of the neutral line, as determined in the last example, to be that of fracture, to determine the weight to be laid on the middle of that piece, when we take into consideration the decreasing energies of the forces of extension and compression?

Referring then to the general formula for the strength of a joist.—

$\frac{sba}{LC}\left(\frac{a}{v+2}+\frac{w+1}{(v+1)(w+2)}(d-a)\right)$ (Art. 15th,) where a is the depth of tension, b the breadth of the piece, d its whole depth, v and w the indices of extension and compression, and s L and C as before.—Assuming C = unity, we have then s = 8000lbs, a, from the last example, = 5·6 inches, b = 12, d = 12, L = 120; v, from the mean of our experiments on extension, ·97, and w, from those of compression, = ·895 (articles 25 and 28) which substituted in the formula give

$\frac{8000\times12\times5\cdot6}{120}\left(\frac{5\cdot6}{2\cdot97}+\frac{1\cdot895}{1\cdot97\times2\cdot895}(6\cdot4)\right)=17743.6$ pounds = the resistance at the end, and 17743·6×2 = 35487lbs. = the true weight on the middle, and which differs from 35840, the result of the preceding example, only 353 pounds, or less than $\frac{1}{100}$ part of the whole weight; and if we have assumed the value of s too small, the difference will not be much greater. Hence then the error arising from supposing the extensions and compressions to be as the forces, is too trifling to be worthy of notice in a thing so anomalous as timber.

Example 4th. Suppose the beam, whose strength is required to be cylindrical, as for instance, the body of a tree?

Its section will then be a circle, fig. 9, in which ABC may be supposed to be the area of tension, and ABD that of compression, the neutral line having been found by Art. 33. And if G be the centre of gravity of ABC, and P and P′ the centres of percussion of ABC and ABD, the formula $\frac{sgA(p+p')}{aLC}$ becomes $\frac{s\,(EG)\times \text{area ABC}\times (PP')}{(CE)\ L.C}$; where EG and PP′ are unknown quantities; and to find them (retaining the previous notation and calling the radius OI $= r$, and AE, $\frac{1}{2}$ the neutral line, $= b$), we have $OG = \frac{(AE)^3}{3.\ \text{area AEC}}$, (Dealtry's Fluxions, Article 64, Ex. 6th) $= \frac{2(AE)^3}{3.\ \text{area ABC}}$ $= \frac{2b^3}{3A}$. And since $OE = r-a$, $\therefore EG = OG - OE = \frac{2b^3}{3A} - (r-a) = \frac{\frac{2b^3}{3}+(a-r)A}{A} = g$.

And now as finding the distances EP and EP′ is attended with too much labour for practical purposes, we shall adopt the following approximation. Let P be the distance of the centre of percussion of the semicircle HIC or HID from the centre O, then EP will be less, and EP′ greater, than P. But as it appears from experiment that AB during moderate strains is near to HI, the excess must be very nearly equal to the defect, or EP+EP′ very nearly $= 2P$; assum-

ing them equal we have $p+p'$ or $PP' = 2P$.

To find P; let any distance $OR = x$, then $RS = (r^2-x^2)^{\frac{1}{2}}$, and the distance of the centre of percussion of the semicircle HID from $O = \frac{\int (r^2-x^2)^{\frac{1}{2}} x^2 \dot{x}}{\int (r^2-x^2)^{\frac{1}{2}} x \dot{x}}$ (when $x = r$)

$= \frac{\frac{cr^4}{16}}{\frac{r^3}{3}}$ (Dealtry, Fluent 25) $= \frac{3}{16} cr$, where $c =$ 3·14159 &c.: P therefore $= \frac{3}{16} cr$; and $p+p'$ $= 2P = \frac{3}{8} cr = \frac{3}{8} \times 3{\cdot}14159\, r = 1.17809$ &c. $\times r$; and the above values of g and $p+p'$ being substituted in the formula give the strength

$$= \frac{s \times \frac{\frac{2b^3}{3} + (a-r)A}{A} \times A \times 1{\cdot}178097 \text{ \&c.} \times r}{aLC} =$$

$$\frac{1{\cdot}178097 \text{ \&c.} \times rs}{aLC} \left(\frac{2b^3}{3} + (a-r)A\right) = \frac{1{\cdot}178097 \times rs}{aLC}$$

$$\left(\frac{2}{3}(2ra-a^2)^{\frac{3}{2}} + (a-r)A\right), \text{ since } b = (2ra-a^2)^{\frac{1}{2}}.$$

Cor. If $a = r$, or the section of tension equal to that of compression, strength $= \frac{s}{LC} \times$ section of tension $\times$ ⅓ diameter.

Example 5th. Suppose it were required to find the strength of a hollow cylinder, the situation of whose neutral line had been previously obtained, as before?

Retaining the last figure, fig. 9th, and the same notation, and supposing the side ABC to be that of tension, we have the arc ACB = A; and if G and P be the centres of gravity and percussion of that arc, and P′ the centre of percussion of the arc of compression BDA, the formula $\frac{sgA(p+p')}{aLC}$ will become $\frac{s\times(EG)\times A\times(EP+EP')}{aLC}$. But $OG = \frac{OC\times AB}{\text{arc } ACB}$ (Dealtry's Fluxions, Art. 64, Ex. 12.) $= \frac{2rb}{A}$; and since $OE = r-a$, $\therefore EG = \frac{2rb}{A} - (r-a) = \frac{2rb-(r-a)A}{A} = g$.

And assuming EP+EP′, or PP′, = twice the distance of the centre of percussion of the semicircular arc IDH from O, (for the same reason as in the last example), and calling that distance = *P*, any distance OR = *x*, the arc DS = *z*, and supposing the arc ACBDA indefinitely thin, we shall have

$$P = \frac{\int x^2\dot{z}}{\int x\dot{z}} = \frac{\int \frac{-rx^2\dot{x}}{(r^2-x^2)^{\frac{1}{2}}}}{\int \frac{-rx\dot{x}}{(r^2-x^2)^{\frac{1}{2}}}}, \text{ since } \dot{z} = \frac{-r\dot{x}}{(r^2-x^2)^{\frac{1}{2}}},$$

(Dealtry 44). But the correct fluent of $\frac{-rx^2\dot{x}}{(r^2-x^2)^{\frac{1}{2}}}$ (when z = a quadrant, or $x = o$) = ·785398 &c. $\times r^3$. In like manner $\int \frac{-rx\dot{x}}{(r^2-x^2)^{\frac{1}{2}}}$ (when $x = o$) $= r^2$. And hence

And taking from the example in art. 33 the values it supplies, and calling the base of the triangle B, and the rest as in Art. 17, we shall have, in fig. 5th, Ec = 1, Ef = 9, cp = 4.872025, DC = B. Hence Ep = 5.872025 = h, ab = $\frac{\text{Ep} \times \text{CD}}{\text{Ef}} = \frac{5.872025 \times B}{9} = .652447 \times B = b$; and since, by art. 17, m and n were such quantities that $m \times \text{Ep} = \text{cp}$, and $n \times \text{Ep} = \text{pf}$, $\therefore \frac{\text{cp}}{\text{Ep}} = \frac{4.872025}{5.872025} = .8297 = m$, and $\frac{\text{pf}}{\text{Ep}} = \frac{\text{cf}-\text{cp}}{\text{Ep}} = \frac{8-4.872025}{5.872025} = .53269 = n$, and these substituted in the formula above give the strength =

$$\frac{s \times .652447 \times B(5.872)^2}{\text{L.C}} \left(\left\{ \frac{(.8297)^3}{3} - \frac{(.8297)^3}{4} \right\} + \left\{ \frac{.8297}{2} - \frac{(.8297)^2}{3} \right\} \times \frac{\frac{.5327}{3} + \frac{(.5327)^2}{4}}{\frac{1}{2} + \frac{.5327}{3}} \right) =$$

$3.4793 \times \frac{s.B}{\text{L.C}}$ = that of the frustum ABCD when $\frac{1}{5}$ of the height of the triangle has been taken away from its vertex.

And for the whole triangle, the values are CD = B, Ef = 9, Ep = 5.799337 (Cor. to example, art. 33) = h. Whence pf = 9 − 5.799337 = 3.200663, $\frac{\text{pf}}{\text{Ep}} = \frac{3.20066}{5.79934} = .55190 = n$, $\frac{\text{Ep}}{\text{Ep}} = 1 = m$, ab = $\frac{\text{CD} \times \text{Ep}}{\text{Ef}} = \frac{B \times 5.79934}{9}$

$= .64437 \times B = b$. And by substituting these in the theorem above, we have the

$$\text{strength} = \frac{s \times .64437 \times B \times (5.7993)^2}{\text{L.C}} \times \left(\left(\tfrac{1}{3} - \tfrac{1}{4}\right) + \left(\tfrac{1}{2} - \tfrac{1}{3}\right) \times \frac{\frac{.5519}{3} + \frac{(.5519)^2}{4}}{\frac{1}{2} + \frac{.5519}{3}} \right)$$

$= 3.1794 \times \frac{s.B}{\text{L.C}}$ = strength of the beam when no part of it has been taken away. And neglecting the deflection in the two cases as inconsiderable, we shall have:

Strength of the part $= 3.4793 \times \frac{sB}{\text{L}}$

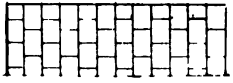
——— of the whole $= 3.1794 \times \frac{sB}{\text{L}}$

Difference $= .2999 \times \frac{sB}{\text{L}}$ = the excess of the strength of the part above that of the whole; a quantity nearly equal to $\frac{1}{10}$ of the strength of the whole beam.

This curious conclusion is analogous to what was shown to be the case in incompressible bodies (arts. 7 and 8), and the reason, why $\frac{1}{5}$th of the height was here chosen to be cut off, was that $\frac{2}{3}$ was found there to be the height of maximum strength.

For the values of s and C, in the preceding examples, and for information connected with the history of this subject, see Mr. Barlow's work, which we have so frequently

referred to in the notes: a work which if we had seen before the reading of this paper, would have caused us in some degree to have changed its form, but the principles must have been entirely the same.



OBSERVATIONS

ON THE

NOTES OF BIRDS,

INCLUDING

AN INQUIRY

Whether or not they are Instinctive.

BY MR. JOHN BLACKWALL.

(Read November 29th, 1822.)

IT is much to be regretted, that the study of ornithology is too frequently confined solely to the perusal of the best authors on the subject, and to the examination and arrangement of preserved specimens, whose faded plumage and distorted forms convey very imperfect ideas of the elegance and symmetry that so eminently distinguish this beautiful and highly interesting part of the creation. To those whom business or inclination leads to reside chiefly in large towns, such are almost the only means of information that offer themselves; but who, that enjoys the opportunity of observing the

free denizens of the fields and woods in their native haunts, would exchange their lively and unrestrained activity, their curious domestic economy, their mysterious migrations, and their wild but delightful melody, for the fixed glassy eye and the mute tongue of the inanimate forms that are crowded together in melancholy groups in the museum. Let me not, however, be misunderstood. I do not mean to insinuate, that those collections of birds that enrich the cabinets of the curious are of small utility; on the contrary, I am willing to allow that their importance is very considerable; but I would anxiously guard against an exclusive attention to the collecting and arranging of specimens, to the neglect of what is much more instructive and valuable: I mean the study of their habits, manners, economy, instincts, and notes. In these important particulars the history of birds is still very defective: the majority of authors, foreign as well as native, having limited themselves to the simple enumeration of specific characteristics and distinctions, and the occasional introduction of a few anecdotes, which from frequent repetition have, in general, lost much of the novelty they once possessed. We must except from this remark, however, the excellent works, in na-

tural history, of our ingenious countryman the late Rev. Gilbert White of Selborne in Hampshire, which abound with new and interesting facts. This diligent observer, whose example in investigating nature cannot be too highly recommended, instead of confining himself to the mere classification of natural objects, ranged the extensive wood, the tangled brake, the solitary sheep-walk, and the treacherous morass, to contemplate the manner of life, dispositions, and peculiar characters, of their feathered inhabitants, in their most sequestered retreats; and his writings bear ample testimony how well his researches were repaid. The subject, however, is still far from being exhausted: knowledge is acquired slowly; and even the most careful and indefatigable inquirers are liable to errors and omissions: much yet remains to be supplied, much to be corrected, before the history of British birds can be pronounced complete.

To the practical ornithologist, who is desirous of promoting and extending his favourite study by the communication of his own personal observations and remarks, an intimate acquaintance with the various notes of the feathered tribes is of such vast importance, that any difficulties he may encounter

in obtaining it, will be more than compensated by the numerous advantages it affords. In many instances it enables him to detect species that might otherwise elude his observation. Thus, the land rail, concealed in the long grass of luxuriant meadows, where it runs with great rapidity, and is sprung with difficulty; the grasshopper warbler, closely embowered in thick hedges and bushy dingles, where it employs every artifice to escape notice; and the sedge warbler, secluded amid the reeds and other aquatic productions of pools and marshes;—are much more frequently heard than seen: the harsh call of the first, the sibilous note of the second, and the hurried song of the last, being repeated through the night, in fine weather, during the breeding season.

It also enables him to identify species with the utmost precision: in some cases, indeed, with much greater certainty than he could by the minutest examination of good specimens. The three species of willow wren, for example, so strongly resemble each other, that even nice observers might have some difficulty in determining them by inspection; and, accordingly, we find that they have been the source of much confusion, perplexity, and error, among writers on ornithology:

as their notes, however, are perfectly distinct, a little attention to them is sufficient to remove every difficulty. In the same manner, the crow may readily be distinguished from the rook, the raven from both, and the males of most species from the females.

The arrival of many of the periodical warblers is frequently first announced by their songs; and the clamorous night-calls of the redwing and fieldfare in the months of October and November, serve to establish the fact, that these birds migrate, and that they perform their journeys in the dark.

But these are not the only advantages to be derived from an acquaintance with the notes of birds. As the feathered tribes communicate their sensations and intentions to one another through the medium of modulated sounds; the proficient, in what, without any impropriety, may be termed their language, can comprehend their various wants and emotions, and can participate in all their little joys and sorrows, hopes and fears: to him, the music of the groves is not a confusion of pleasing tones merely, but the melodious interchange of thought and feeling; which, though very limited and imperfect, still answers many important purposes, and contributes materially to the happiness and

preservation of species. Thus, birds that congregate and that live in society have usually a regular watch stationed in some commanding situation, whose note of alarm is understood by the whole community: of the truth of this observation, fieldfares and rooks furnish familiar and striking instances. The shrill call of the swallow, the harsh scream of the jay, the petulant cries of the various species of titmouse, and the plaintive wailing of the flycatcher, likewise intimate the approach of an enemy. The reiterated cackle of the domestic hen after she has laid, speedily announces the joyful event; her cluck indicates that she has become the mother of a family; by a peculiar call she informs her brood whenever she discovers any thing suitable for food; and her shriek is a warning against impending danger. What is usually called the prating of poultry is expressive of satisfaction and complacency: but it is needless to multiply examples, or to insist further on the many useful purposes to to which a familiarity with the language of birds may be rendered subservient: it will suffice to remark, that this knowledge supplies the means of making fresh discoveries, of correcting numerous errors, and of removing many of those doubts and difficulties

that have arisen from the great similarity of some species, and the peculiarities incidental to age, sex, and a change of food or climate in others, without placing the observer under the painful necessity of destroying life:—a recommendation which will be duly appreciated by every one possessed of a humane disposition and a reflecting mind.

Having endeavoered in these few preliminary observations to point out the great importance of attending to the notes of birds, I shall now proceed to an inquiry into their origin:—an inquiry well calculated toe xercise the skill of the experimentalist, and the ingenuity of the speculative philosopher; though to the generality of mankind it may seem trivial and of little moment.

The only author that I am acquainted with, who has treated this curious subject at any length, is the Honourable Daines Barrington; in an essay entitled "Experiments and Observations on the Singing of Birds," published in the second part of the sixty-third volume of the Transactions of the Royal Society: and as the experiments there detailed appear to be imperfect and unsatisfactory; and the conclusions drawn from them, hasty, unwarranted, and contrary to common experience; and, more especially, as this

author is generally referred to by our cyclopædists,* and as his opinions seem to be finding their way into modern works of respectability, where they are quoted as established facts that do not admit of a doubt;† it was thought, that an examination of his method of investigation would be useful in exposing its insufficiency, and the consequent looseness of the arguments founded upon it; while the institution of a less exceptionable course of experiments, it was hoped, might dissipate much of the obscurity in which this intricate question is at present involved. In what degree these expectations have been realized remains to be shewn.

Mr. Barrington informs us, that his experiments were principally made with young linnets which were fledged, and nearly able to leave the nest; and the reasons assigned for this selection are, that birds of this species are docile, and possess great powers of imitation, and that the cocks are easily distinguished from the hens at an early period. These nestling linnets were educated under singing birds of various kinds; and it appears, that

* See the Encyclopædia Britannica, Art. Singing; and Rees' Cyclopædia, Art. Song.

† See Bingley's Animal Biography, Vol. II p. 166—7.

instead of the linnet's notes, they learned those of their respective instructors, to which they adhered almost entirely. In some instances, to be sure, the nestlings retained the call of their own species; which, as they were three weeks old when taken from the nest, it is supposed they had learned from their parents; and not unfrequently when they had opportunities of hearing several species, they borrowed from more than one, and their songs became mixed.*

To be certain that nestlings will not have even the calls of their species, Mr. Barrington remarks, that they should be taken when only a few days old. He then proceeds to notice instances of a linnet and a goldfinch taken at this early period, that came under his observation; acknowledging, at the same time, his own inability to rear birds of so tender an age. The first, he states, "belonged to Mr. Matthews, an apothecary at

* The reason given by Mr. Barrington for the steady adherence of birds in a wild state to their own songs, is, that they attend to the instructions of the parent birds only, disregarding the notes of all others. That young birds receive instructions in singing from the old ones, appears to be a notion of great antiquity. Vide Aristot. Histor. Animal. Lib. IV, Cap. IX.---Plinii Histor. Natural. Lib. X, Cap. XXIX. The celebrated Count Buffon seems to have entertained a similar opinion. See his Histoire Naturelle des Oiseaux. Tome cinquième, p. 47. Darwin also, in his Zoonomia. Vol. 1, p. 155, lends it the sanction of his authority.

Kensington, which, from a want of other sounds to imitate, almost articulated the words 'pretty boy,' as well as some other short sentences;" and the owner assured him, that it had neither the note nor call of any bird whatsoever. The goldfinch had acquired the song of the wren, without appearing to have a note or even the call of the goldfinch.

From these experiments and observations, of which I have given a concise, but I trust impartial account, Mr. Barrington was led to conclude, that "notes in birds are no more innate than language is in man, but depend entirely upon the master under which they are bred, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing." I am not aware, however, that he has brought forward a single fact, from which such an inference can be fairly deduced. The main tendency of his researches is merely to prove (what was before perfectly well known) that some birds have very extraordinary powers of imitation, and may be taught, when young, to sing the notes of other species, whistle tunes, or even pronounce a few words. If his remarks on this subject contain any novelty, it is, that birds so educated sometimes remain satisfied with these imitations, never

blending any of their own notes with them; and, indeed, on this solitary circumstance, slight and inconclusive as it is, the entire weight of his arguments is rested. The instances of the goldfinch acquiring the song of the wren, and Mr. Matthews' linnet learning to articulate one or two short sentences, without having even the calls of their species, which this author seems to think so decisive, prove no more than his own experiments; which, as they were made, for the most part, with birds remarkable for their imitative powers, were certainly by no means well adapted to his purpose. As for the goldfinch, Mr. Barrington heard it only once, and then but for a short time; and that no dependance could be placed on any report of the people to whom it belonged, is evident from their supposing that it sang its own notes. These are circumstances that powerfully tend to invalidate almost every thing of importance that has been advanced respecting this bird.

In order to ascertain whether nestlings when taken very young will or will not have the calls and songs of their species, they should be kept in situations where they have no opportunity of learning any sounds that

they may substitute for them; but this, I believe, has never yet been attempted.

I have already asserted, that Mr. Barrington's conclusions are contrary to common experience. I shall now endeavour to establish this charge.

It is well known to most persons who have the care and management of poultry, that ducks, guinea fowls, &c., hatched under the domestic hen, and domestic fowls hatched under turkeys, have the calls and habits peculiar to their species: that this is the case also with pheasants and partridges, brought up under similar circumstances, I have had frequent opportunities of observing. It is a matter of universal notoriety likewise, that all cuckoos of the species canorus, though hatched and reared by birds of various descriptions, have constantly their proper calls.*

* Mr. Barrington will not allow that the well known cry of the cuckoo is a song, because it does not happen to accord with the conditions of his arbitrary definition; though, to the bird, it answers every purpose of a song, as well as the more elaborate effusions of the nightingale and skylark. Mr. Barrington defines a bird's song to be a succession of three or more different notes, which are continued without interruption, during the same interval with a musical bar of four crotchets in an adagio movement, or whilst a pendulum swings four seconds; which necessarily excludes the chaffinch, redstart, hedge warbler, willow wren, and some others, that have always been accounted birds of song, as well as the cuckoo, from any pretensions to the title. Perhaps it would be more natural, and certainly less exclusive, to apply the term song to those notes that are peculiar to the males; yet this defini-

These facts one would suppose were quite sufficient to convince the most prejudiced, that birds do not always acquire the calls and notes of those under which they are bred. But, perhaps, it may be urged, that ducks, guinea fowls, pheasants, and partridges, are probably incapable of learning the calls of domestic fowls; that domestic fowls, in their turn, may be incapable of acquiring the call of the turkey; and that the cuckoo appears to be very poorly qualified for imitating the notes of its foster parents. Still I must contend, that the incapacity of these birds has never been proved; and even if it had, it would afford no explanation of the manner in which they become acquainted with their own respective calls. According to Mr. Barrington's theory they ought to be mute; or, at least, should have such notes only as they have been able to pick up casually; which, of course, would possess little or no resemblance.

From these, and similar observations, I have long been thoroughly convinced myself, that the calls of birds, which seem to be the simplest expressions of their sensations, are

tion would admit the peacock and turkey into the catalogue of singing birds; and the hideous scream of the one, and the ludicrous gobble of the other, are certainly any thing but musical.

natural, not acquired; and in order to determine whether this is the case with their songs also, which are generally much more complex, and, consequently, have the appearance of being more artificial, the following experiments were made.

In the summer of the present year, (1822,) I procured three young green grosbeaks,—a cock and two hens; which, as they did not see till the fourth day after they were taken from the nest, must then have been only two days old.*

These birds were reared by hand, in a house situated in the town of Manchester; where they had no opportunity of hearing the notes of any bird, except, perhaps, the occasional chirping of sparrows: nevertheless, they had all their appropriate calls, and the cock bird had the song peculiar to its species.

It was hoped, at the time, that this experiment would be considered sufficiently decisive; but recollecting that some persons, for the sake of shewing their ingenuity in raising objections, might say that these birds remembered the notes of their parents, which they imitated as soon as they had acquired

* From numerous observations that I have made, it appears that young birds usually begin to see about the sixth day after they are hatched.

the power; and being willing to remove every circumstance on which the most fastidious inquirer could fix a doubt, I placed the eggs of a redbreast in the nest of a chaffinch, and removed the eggs of the chaffinch to that of the redbreast; conceiving, that if I was fortunate in rearing the young, I should by this exchange insure an unexceptionable experiment, the result of which must be deemed perfectly conclusive by all parties. In process of time these eggs were hatched, and I had the satisfaction to find that the young birds had their appropriate chirps.*

When ten days old they were taken from their nests, and were brought up by hand, immediately under my own inspection; especial care being taken to remove them to a distance from whatever was likely to influence their notes. At this period, an unfortunate circumstance, which it is needless to relate, destroyed all these birds, except two,—a fine cock redbreast, and a hen chaffinch; which, at the expiration of twenty-one days from the time they were hatched, commenced the calls peculiar to their species. This was an important point gained, as it evidently proved

* Mr. Barrington defines the chirp to be the first sound a young bird utters as a cry for food. It consists of a single note, repeated at short intervals, and is common to nestlings of both sexes.

that the calls of birds, at least, are innate; and that, at this early age, ten days are not sufficient to enable nestlings to acquire even the calls of those under which they are bred; thus, clearly establishing the validity of the first experiment made with the young green grosbeaks. Shortly after, the redbreast began to record;* but in so low a tone, that it was scarcely possible to trace the rudiments of its future song in these early attempts: as it gained strength and confidence, however, its native notes became very apparent; and they continued to improve in tone, till the termination of July, when it commenced moulting; which did not, as was expected, put a stop to its recording.† About the middle of August it was in deep moult, and by the beginning of October had acquired most of its new feathers. It now began to execute its song in a manner calculated to remove every doubt as to its being that of the

* The first endeavours of a young bird to sing are termed recording.

† The important operation of moulting undoubtedly affects the singing of wild birds very considerably; and may, perhaps, be a principal cause of their silence in the month of August. The London birdcatchers are well aware of the advantages of occasioning their call-birds to moult prematurely, which, by this means, are brought into full song, while other birds are nearly mute. For an account of the manner in which this is effected, see Pennant's British Zoology. Vol. II, p. 332.

redbreast, had any such previously existed:* its habits also were as decidedly characteristic as its notes, and I am the more particular in noticing this latter circumstance, because the peculiar habits of birds are quite as difficult to account for as the origin of their songs.† Thus, it appears from this satisfactory experiment, which was conducted with the utmost care, that, contrary to Mr. Barrington's opinion, the notes of birds, which probably consist of those sounds that their vocal organs are best adapted to produce, are perfectly innate.‡

* Montagu, in the introduction to his Ornithological Dictionary, p. 29, states, in a note, that "a goldfinch, hatched and fostered by a chaffinch, retained its native notes," but does not give any further particulars respecting this bird.

† Several birds sing in the night, and some warble as they fly. The titlark uses particular notes in ascending and descending, and the song of the white-throat is accompanied with strange gesticulations. Larks and wagtails run; finches and buntings hop; nearly the whole of the gallinaceous and pie tribes, and many species of waterfowl walk; and woodpeckers climb. The sparrow, skylark, and most of the gallinæ are pulveratrices; and the kestril is, I believe, the only British hawk that hovers. The peculiar modes of flight and nidification are equally remarkable and worthy of notice, but, as they are foreign to the present subject, I shall not now dilate upon them.

‡ Since writing the above, I have met with the following general assertion, unaccompanied by any evidence in support of it, in the Physiognomical System of Drs. Gall and Spurzheim; by J. G. Spurzheim, M. D. Second edition, p. 194---5. "Singing birds, moreover, which have been hatched by strange females, sing naturally, and without any

Having shewn that the notes of birds are natural, or, in other words, that they do not depend upon any previous instruction, it follows, that they must furnish the attentive ornithologist with an excellent method of distinguishing species, under all the various circumstances that are liable to affect their plumage; though it must be observed, that the great similarity so evident in the songs of birds of the same species is more in tone and style, than in the individual notes of which they are composed.*

I shall here remark, that it is highly probable that no bird, in a wild state, ever borrows the notes of others, or becomes a mocker. I am well aware, that several of our native birds, as the pettychaps and sedge warbler, have usually been termed mocking birds: but this is certainly improper; as they constantly use their own natural notes, and no others, they do not at all merit this appellation. The fine strain of the first has been thought to bear a striking resemblance to those of the

instruction, the song of their species as soon as their internal organization is active. Hence the males of every species preserve their natural song, though they have been brought up in the society of individuals of a different kind."

* Birds of the same species do not always deliver their notes exactly in the same order of succession; neither do they uniformly use precisely the same notes.

swallow and blackbird: this, however, must be entirely imaginary, as it is totally different from them in manner and notes: if it be possible to trace any similarity between them, it will be found to consist in tone merely. The song of the sedge warbler is wonderfully varied, and appears to be chiefly composed of passages borrowed from the songs of the skylark, titlark, white-throat, whinchat, lesser redpole, swallow, &c. Now if any bird is entitled to the epithet of mocker, surely it is this: yet these resemblances are common to the songs of the whole species, which inhabit situations very unsuitable for acquiring some of them. In short, these fancied imitations are not studied, but purely accidental, consisting of their own notes ab origine.

The singing of birds has been very generally attributed to the passion of love, and a desire of pleasing their mates.

> "'Tis love creates their melody, and all
> This waste of music is the voice of love;
> That even to birds, and beasts the tender arts
> Of pleasing teaches."*

Thus the great poet of nature elegantly expresses the idea. This opinion, however, does not appear to be well founded: their language of love, their amorous strains, consist of low intermitted tones, accompanied with ridiculous

*Thomson's Seasons, Spring.

gesticulations; and are altogether different from their ordinary songs, which seem to be occasioned by an exuberance of animal spirits, arising from an abundance of nourishing food, and an increase of temperature, and by a spirit of emulation and rivalry among the males. In confirmation of what is here advanced, I shall observe, that I have known many instances of birds having nests after they have entirely ceased singing; and that some species, as the woodlark, redbreast, and wren, sing long after they have done breeding: caged birds also continue in song much longer than birds at large, though they have no mates to solace and amuse; and it is remarkable, that almost any kind of continued noise is sufficient to stimulate them to sing. That birds of the same species distinguish each other by their notes, better than by any other circumstance, and that the songs of the males serve to direct the females where to seek their society, as Montagu has suggested, appears to me highly probable; but I must differ from this ingenious writer, when he asserts, that love is the sole cause of their songs.* In support of this opinion he states, that the males of our warblers, before they

* This he does, in effect, in the introduction to his Ornithological Dictionary, p. 28, and following.

pair in spring, sing almost incessantly, and with great vehemence; that from the time of pairing till the hens begin to sit, they are neither so vociferous, nor so frequently heard as before; that during the time of incubation their songs are again loud, but not so reiterated as at the first; and that so soon as the young are excluded from the eggs, they cease singing entirely:* but it may be remarked, that if they are not heard so frequently and earnestly after pairing as before, most probably it is because they are occupied in attending to the females; and I have already observed, that their amatory notes, which they chiefly use at this period, are totally different from their ordinary songs. When the hens are sitting, or by any accident happen to be separated from their mates, the attention of the latter is much less engrossed; their notes of love are suspended, and their customary strains renewed. It is a very mistaken notion of Montagu, that the songs of these birds cease immediately when their eggs are hatched, as, in numerous instances, it is notorious that they continue even for some time after the young have left the nest. Surely it is needless to insist, that it cannot

* See the Introduction to the Ornithological Dictionary, p. 30, 31.

be love that prompts the young males to attempt their songs so soon as they are known to do :* besides, it has been shewn, that when educated early under other species, they sometimes possess their notes exclusively, which would hardly be the case, if love is their only motive for singing.

For the information of those who may wish to be acquainted with the singing birds of this particular neighbourhood, I subjoin the following catalogue.

* Young birds frequently begin to practise their songs when only a month old.

A Catalogue of Singing Birds, heard in the Neighbourhood of Manchester; with the Periods at which they commence and discontinue their Songs, taken at a mean of five years' observations.

Birds.	Commence Singing.	Cease Singing.
1 Redbreast——Motacilla rubicula	Jan. 3	Dec. 14
2 Wren——Motacilla troglodytes*.....	do 13	do. 3
3 Missel Thrush——Turdus viscivorus†....	Feb. 1	May 28
4 Throstle——Turdus musicus	do. 8	Aug. 12
5 Skylark——Alauda arvensis	do. 9	July 8
6 Hedge Warbler——Motacilla modularis..	do. 9	do. 19
7 Chaffinch——Fringilla cœlebs.....	do. 10	do. 7
8 Starling——Sturnus vulgaris	do. 15	May 30
9 Blackbird——Turdus merula	Mar. 20	July 13
10 Green Grosbeak——Loxia chloris	do. 24	Aug. 12
11 Titlark——Alauda pratensis	April 4	July 9
12 Lesser Redpole——Fringilla linaria	do. 5	Aug. 5
13 Woodlark——Alauda arborea	do.	Oct. 25
14 Goldfinch——Fringilla carduelis	do. 11	June *
15 Redstart——Motacilla phœnicurus	do. 14	do. 29
16 Willow Wren——Motacilla trochilus....	do. 14	Aug. 23
17 Linnet——Fringilla linota	do. 15	July 6
18 Lesser Fieldlark——Alauda minor.....	do. 17	do. 8
19 Swallow——Hirundo rustica	do. 19	Sep. 25
20 Stonechat——Motacilla rubicula	do. 24	June
21 Whinchat——Motacilla rubetra	do. 25	July 1
22 Black-cap——Motacilla atricapilla	do. 25	do. 22
23 White-throat——Motacilla sylvia.....	do. 29	do. 16
24 Pettychaps——Motacilla hortensis.....	May 12	do. 11
25 Sedge Warbler——Motacilla salicaria‡ ..	do. 17	do. 16

* The redbreast and wren sing at all times of the year, except during severe frost; and several species of birds that cease singing about the latter end of July, or the beginning of August, are sometimes heard again in autumn, when their songs are generally feeble, imperfect, and of short continuance, like the early efforts of our warblers in spring.

† The missel thrush is the largest British bird of song.

‡ In this catalogue I have omitted the yellow bunting, reed bunting, golden-crested wren, yellow willow wren, and some others, that have not uniformly been accounted singing birds.

It would be difficult, nay impossible, to convey a distinct idea of the songs of these birds by any verbal description: indeed, the delightful associations they excite, with the adventitious circumstances of time, distance, situation, &c., so greatly influence their effect, that even the best imitations are utterly inadequate to produce any thing equal to it.

Mr. Barrington, in his essay, has attempted to construct a table, by which the comparative merits of British singing birds may be examined; but as he does not appear to have formed a correct estimate of the songs of some species, and as his table is inaccurate in other respects, besides being too limited, I have endeavoured to supply one that will be more comprehensive, and, I trust, less objectionable; making, as he has done, the number 20 the point of absolute perfection.

TABLE.

BIRDS.	Mellowness.	Sprightliness.	Plaintiveness.	Compass.	Execution.
1. Nightingale..,....	19	14	19	19	19
2. Skylark	4	19	4	18	18
3. Black-cap	14	12	12	10	8
4. Pettychaps	14	6	14	10	9
5. Redbreast	9	8	12	14	14
6. Linnet	10	15	6	12	13
7. Woodlark	18	2	17	8	6
8. Goldfinch	4	16	4	10	12
9. Sedge Warbler*..	2	16	0	18	14
10. Lesser Fieldlark..	8	7	5	4	5
11. Willow Wren....	6	4	5	5	5
12. Throstle	3	10	2	10	4
13. Blackbird..,.....	8	1	4	5	3
14. Chaffinch.....	2	14	1	4	5
15. Green Grosbeak ..	5	3	5	5	5
16. Hedge Warbler..	3	4	3	4	4
17. Wren	1	16	0	4	5
18. Swallow	4	6	2	3	3
19. Missel Thrush....	3	4	1	5	3
20. Starling	4	2	2	4	2
21. Titlark.....	3	2	2	2	2
22. Siskin	1	4	0	3	3
23. Lesser Redpole....	1	4	0	3	3
24. White-throat....	1	4	0	3	3
25. Redstart	1	4	0	2	2
26. Stonechat.....	1	3	0	3	2
27. Whinchat	1	3	0	2	2
28. Dartford Warbler					
29. Water Ouzel†					

* Mr. Barrington has inserted the chaffinch, hedge warbler, and reed sparrow, in his table; which (according to his definition of a bird's song) ought not to have been admitted: indeed, the notes of the reed sparrow are so mean, that I am inclined to believe that he has attributed the song of the sedge warbler to this species, especially, as he remarks, in a note, that it sings in the night: an error by no means uncommon among ornithologists,—yet, if this is the case, he has greatly underrated it; for though harsh in tone, and hurried in manner, and though the same note is repeated frequently in succession, it certainly possesses great variety, and is, upon the whole, rather agreeable.

† I have included the Dartford warbler, and the water ouzel, on the authority of Montagu. (See the Supplement to his Ornithological

This long catalogue of birds, most of which, it appears, are to be found in this immediate neighbourhood, composes the feathered choir, that enlivens the pastoral scenery of England with a rich and varied melody of song which probably is not surpassed in any part of the known globe.

The following poetical description of the vernal chorus, with which I shall close these observations, is from Thomson's Seasons, Spring.

"Up springs the lark,
Shrill voic'd, and loud, the messenger of morn;
Ere yet the shadows fly, he mounted sings
Amid the dawning clouds, and from their haunts
Calls up the tuneful nations. Every copse
Deep-tangled, tree irregular, and bush
Bending with dewy moisture, o'er the heads
Of the coy quiristers that lodge within,
Are prodigal of harmony. The thrush
And wood-lark, o'er the kind contending throng
Superior heard, run through the sweetest length
Of notes; when listening Philomela deigns
To let them joy, and purposes in thought
Elate, to make her night excel their day.
The blackbird whistles from the thorny brake;
The mellow bullfinch answers from the grove:
Nor are the linnets, o'er the flowering furze

Dictionary.) The former I never saw alive, and, therefore, could have no means of estimating its song; and though I am well acquainted with the latter, I have never had an opportunity of hearing its notes.

Pour'd out profusely, silent. Join'd to these,
Innumerous songsters, in the freshening shade
Of new-sprung leaves, their modulations mix
Mellifluous. The jay, the rook, the daw,
And each harsh pipe, discordant heard alone,
Aid the full concert; while the stock-dove breathes
A melancholy murmur thro' the whole."

ON THE SALINE IMPREGNATION OF THE RAIN,

Which fell during the late Storm, December 5th, 1822.

BY JOHN DALTON, F. R. S. &c.

(Read December 13th, 1822.)

It is well known that the spray of the sea during a storm, is often carried inland by the wind to a considerable distance. I have read accounts of salt having been found on windows many miles from the sea, after a storm of wind; but I do not recollect at present where the accounts are given, nor what kind of authority is given for them; and the time I have had to draw up this memoir does not allow me to consult many books.

On the 6th instant (the day after the memorable storm) Mr. John Blackwall and Mr. John Potter called on me to enquire if I had observed the salt which was to be found on most windows exposed less or more to the

weather: upon my answering in the negative, they immediately pointed out the phenomenon on the window of my room. Mr. Blackwall produced a moist sponge, with which he had rubbed a window thus circumstanced, and requested me to examine chemically whether the water contained any common salt. On washing the sponge in distilled water, I found, by the usual test, namely, nitrate of silver, that the water exhibited decisive marks of the presence of muriatic acid. My own window, treated in the same manner, also gave clear traces of muriatic acid. Since which I have tried other windows exposed to the storm, all of which yielded less or more of muriatic acid.

Suspecting that the sponge might naturally contain a portion of salt, I washed it well in pure water, and then applied the test to water expressed from it, when scarcely any trace of the acid was to be found; and the little that appeared was evidently the residue of what had previously been imparted by the forementioned applications of the sponge to the windows.

These observations on the effects of the storm upon the windows on the late occasion, have not been confined to two or three individuals, but have been very general. Seve-

ral people have been struck with the phenomenon, and have mentioned it in my hearing, without my having obtruded it upon their notice. From this I am led to conclude that the effect has perhaps been greater than in any former instance remembered. These considerations have induced me, in the absence of more important matter, to throw a few observations on the subject before the society.

The facts and observations above-mentioned may be thought sufficient to establish the opinion, that salt water is sometimes brought to this distance from the sea in a storm; but I was desirous to corroborate the evidence by other observations. It occurred to me that the water collected from the houses at that time ought to shew unusual signs of salt. I happened to have some rain water that had been collected from the society's premises previously to the storm: this was examined, and found to contain the most minute trace of muriatic acid. The water in the same tub after the storm was next examined: the tub was nearly full when the rain began to fall on the 5th instant; but as the quantity of rain was great, and it all ran into the tub before the overflow, the waters must have been well mixed. It was found to have 20 or 30

times the salt that the former water had. This excess was more than I expected; and as the tub was at the time accessible to others besides myself, I thought it possible that some salt might have been imparted to the water in addition to that brought by the wind.

Another thought occurred; the water of my rain-gage was the produce of the storm chiefly; and, not having been in contact with the slates of the house, it appeared to be unexceptionable. I examined it and found it to contain 1 grain of salt in 7500 water; it was of course very sensible to the test of nitrate of silver. Reflecting upon this result, I was led to suspect that the bottle receiving the rain, being of earthenware, and glazed with common salt, was not a suitable vessel to contain water in the present case. This threw a doubt upon the result from the gage-water. However, the produce of a succeeding rainy day was also examined, and it was found to contain $\frac{1}{8}$ of a grain of salt in 7500 water. The disproportion of salt in the two cases is very great; but why was there any salt at all in the last water? It cannot, I think, be referred to any other source than the glazing of the bottle. If this be allowed, the *time* the water remains in the bottle will have some influence on the quantity of salt

extracted; now the water of the 5th instant was five times as long in the bottle as the latter quantity, and may therefore be supposed to have got four or five times as much salt; but it had eight times as much; so that still an excess of salt appears on the 5th, which cannot be accounted for without supposing it to be introduced by the rain.

In order to be fully satisfied on the subject I undertook another analysis. I collected a quantity of water from a lead cistern, for rain water, the surface of which was inaccessible to any one, and consequently the water could not have been modified, either by accident or design. This was done on the 6th instant just after the fall of rain. Fortunately I had also access to a quantity of water drawn previously to the storm, from the same cistern, into a wooden tub, as a reserve for domestic purposes.

These two kinds of water were examined, the cistern water of the 5th December corresponded with the rain-gage water of the same day; and the tub water corresponded with the gage water that fell a few days after the storm, as far as regards the quantity of muriatic acid which they respectively contained.

Collecting now these results into a Tabular form for the sake of comparison,—

	grains.
1. Found in 7500 grains rain water from tub on the Society's premises after the 5th December	3 muriate soda.
2. Found in 7500 grains rain water from rain-gage just after the storm.....	.86———
3. Found in 7500 grains rain water from the lead cistern, taken just after the storm	.81———
4. Found in 7500 grains rain water from lead cistern, taken before the storm; also in the same quantity of rain water in the gage taken from the produce of a rainy day subsequent to the storm...	.13———

It is scarcely necessary to observe that I have assumed all the muriatic acid found to be combined with *soda*, though it is well known that sea-water contains muriate of *magnesia*, &c., as well as common salt. My object is to shew that sea-water was brought by the wind, without enquiring into the proportion of its elements.

In order to form a judgment which of these waters is most likely to give a correct indication of the quantity of saline matter brought by the storm, we must consider that the water of the rain-gage can on no account *under rate* the quantity of salt. The bottle might impart salt to the water, but could not abstract any from it. The water of the lead

cistern (No. 3.) ought not to *overrate* the quantity of salt, because it was mixed with less or more of other water previously in the cistern; but then as a compensation for this mixture there is the quantity of muriatic salt arising from the washing of the slates, if any such exist. This quantity (supposing it to exist) may be considered as constant, and may be inferred from the result stated in No. 4; and it is a curious coincidence that the slates of the house appear to furnish the same quantity of salt to the cistern water as the rain-gage bottle does to its contents. If therefore we take .13 from .81 we shall have .68 remaining, for the quantity of salt; which must be *less* than that brought by the rain, by reason of the mixture above mentioned. Now as No. 2 (.86) must be *more* than the correct number, and this last (.68) must be *less* than the correct number, the *mean* (.77) may be safely inferred as a near approximation to the true quantity of salt in 7500 grains of rain water which fell on the 5th instant. In round numbers 1 grain of salt in 10000 grains of water. But sea water contains 1 grain of salt in 25 water; hence 1 grain of sea water must have been found in every 400 grains of rain water, on that memorable occasion.

We may now speculate upon the cause of this great influx of sea-water:—as salt is known not to evaporate, there can be but one opinion as to the cause; it must be brought by the violent impetuosity of the wind acting upon the spray from the tumultuous waves of the ocean. The storm was from the S. W. to the W. The S. W. wind comes from the coast of Wales, distant 100 miles, over an uneven country, which would contribute to whirl the spray up into the clouds, and might well suspend it for half an hour or more during its passage. The west wind would have a shorter passage of only 30 or 40 miles from off Liverpool. The great resistance which the air occasions to the descent of minute drops of water, is evinced from the great progress of clouds, without much apparent descent even in a moderate current of air. I think it is not improbable in such a storm that the salt water might be carried across the island. And it may be worth future enquiry whether a moderate breeze from the W. or S. W. may not frequently bring us some traces of salt water with the rain, when the quantity is too minute to be detected by common observation, but may probably be shewn clearly by the usual chemical tests.

OBSERVATIONS

ON

THE ROUND TOWERS

OF IRELAND.

BY ROBERT HYDE GREG, ESQ.

(Read before the Society, March 7th, 1823.)

On Lough Neagh's bank, as the fisherman strays,
When the clear cold eve's declining,
He sees the Round Towers of other days
In the wave beneath him shining.

Moore's Irish Melodies.

We never regard without feelings of lively interest, never contemplate without emotions of pleasure, any monument of antiquity, however small its remains, or rude its construction, however obscure its origin, or unintelligible its use, or whatever may be the story, real or fictitious, with which it is connected. The pleasure so derived is sometimes, it is true, of a melancholy nature. The object we look on may lead us to reflect on the ages gone by, and nations swept from the face of the earth since its erection. It may be a tomb which covers the ashes of a hero

who died in the arms of victory, and we may grieve to think, that he, who sowed the seed, did not live to reap the harvest of glory; or it may have been raised over some faithful pair,—a sad memorial, that love, however fascinating, may be clouded by sorrow, and be fatal in its termination. It may remind us that the efforts of patriotism have not always been successful, that piety and virtue have sometimes been rewarded with martyrdom, and philosophy with persecution; that beauty has withered in its prime, and power been blasted in its might: but the emotions thus excited being pure and disinterested, and the feelings awakened, kindly and sympathetic, they will ever be found to partake more of pleasure than of pain.

The rudest and most ancient monuments of former times, we regard with feelings not far removed from that superstitious awe, so common among the vulgar; or we amuse ourselves with fruitless speculations as to their origin and use: some are interesting because they furnish an insight, however faint, into the manners, religion, arts, wealth, and state of civilization, of nations now no more, and of people, whose very names are forgotten. Others again delight us, not only from the light they throw on the state of

ancient nations, but from their intrinsic worth, as perfect models of sculpture and architecture. But, excepting in such cases as these, the great source of interest arises from the history attached to them, rather than from any attraction inherent in the monuments themselves. This will not only greatly increase the pleasure we derive from the contemplation of the noblest object, but create a new source of interest, which, without it, could have had no existence, and impart to a green mound, or shapeless stone, charms which the loftiest column, or most beautiful temple, can never possess.

A question here presents itself of some importance, viz., how far it is prudent to probe too strictly into the authenticity of its claims, where an object, possessing no intrinsic merit, derives its principal, or perhaps its sole interest, from its connection with history or romance. It is always painful to have agreeable associations destroyed, and since the result of our investigation might, or indeed probably would, strip the object we have hitherto regarded with pleasure, of all which rendered it interesting, is not this a case where "Ignorance is bliss," and where "it is folly to be wise?"

The traveller, who, moved by tender recollections, visits the stone coffin of the unfortunate Juliet, at Verona, is offended by the suggestion that it is a water-trough; and perhaps those, who have been accustomed to regard the Round Towers of Ireland as the proper objects of poetry and romance,—as the only records of an age, about which history is silent, and who have credited the strange reports, or indulged in the fanciful theories of their origin and application, will be as little pleased at our attempting to prove that they are Belfries.

The love of truth ought, perhaps, to lead us thoroughly to sift the pretensions of every thing claiming our attention and regard; yet, where the object is in itself trivial, and destitute of all interest except that derived from its connection with some history, delusion is no less harmless than agreeable, and may safely be indulged. But when the object is an important one, where it occupies a principal station in the antiquities of a country, and of our own in particular, we must not wilfully allow ourselves to remain in a state of ignorance or uncertainty. Of such a nature are the Irish Round Towers:—they stand foremost in the ranks of our antiquities, and

though there are perhaps few ancient monuments, whose origin and use may, we think, be ascertained with more correctness than these, there are certainly none, respecting which more absurd suppositions have been resorted to, or more groundless theories constructed.

Description of the Round Towers.

In Ledwich's Antiquities of Ireland, we have a list of 65 Round Towers; but, either this number is exaggerated, or some have been destroyed, or otherwise disappeared since his time, for at present there remain only 59 or 60.

There is a striking similarity between all the Round Towers in general character. They strongly resemble each other in form, masonry, and style of architecture; and they differ in little but their dimensions. They are quite round, taper as they ascend, not rapidly, but generally in a proportion easy and graceful, and they terminate at the summit in a conical stone roof. The greatest difference in the Round Towers is in their height, which generally varies from 30 feet to 100 feet. Three, namely, those of Kilmacduagh, Kildare, and Monasterboice, are

110 feet high, that of Fertagh 112 feet, and one, that of Drumiskin, attains the extraordinary elevation of 130 feet. (A)

The circumference at their base does not vary in proportion to the difference in their height. The circumferences of the three just enumerated as 110 feet high, are 57, 51, and 54 feet, whilst that of Timahoe is 53 feet, though its height is only 35 feet. We cannot find any measure of that of Drumiskin, but it would probably be found not to exceed 60 feet. The circumference of the Towers of Kilcullen and Abernethy is the same, but the height of the former is double that of the latter. It is evident, therefore, that whilst some of the Round Towers are remarkably slender and elegant in their proportions, others are short, heavy, and clumsy. The thickness of the walls varies from 3½ to 4½ feet. They have all been once divided into three or more stories, some containing as many as seven. The floors of these stories must have been of wood, and have universally disappeared. They were supported, sometimes by projecting stones, or a projecting circular rim, and sometimes by the joists being let into the walls. In many, if not in all cases, each story is lighted by a

(A) Ledwich's Antiquities of Ireland, page 168.

narrow window, or niche in the wall; and every Tower, without exception, has four large arched apertures or windows at the top, opposite to each other. We are not aware, whether the direction of these windows is the same in all, or indeed whether any particular direction of them is ever observed, and we do not consider it as a matter of any importance in our enquiry.

The entrance to the Round Towers is by an arched door; sometimes the pointed arch, sometimes the round one is used: and, what is remarkable, the door is generally at a considerable height from the ground, varying in most from 10 to 15 feet. The one at Swords however has its door only 2 feet, whilst that at Kilmacduagh has it 24 feet above the ground. There are no stairs or other visible means of reaching the door. The masonry is generally rude, and the style of architecture simple to the last degree, for, with a few exceptions, the Towers are totally destitute of ornament. The Round Tower on Devenish Island, Loch Erne, has a rich cornice, with a carved head over each window; that at Swords is surmounted by a cross; and the one at Kildare has a little battlement round the top, but it is possible that both these may be modern additions. That at Donoughmore has a figure of our Saviour sculptured on the

key-stone of the door; but whether this is as ancient as the tower itself is a point open to discussion. The Tower at Kilmacduagh is remarkable for two peculiarities: in the first place, it leans very much from the prependicular, and though 110 feet high, is quite perfect, and, apparently, without a crack; and secondly, it is built in a style of masonry which we have never before observed in Ireland. The stones, which are of a great size, instead of being squared, are fitted to each other whatever their shape, and this has been done with such labour and accuracy, that the seams between the stones are as minute, and the building as compact, as if built of squared stone.(B) Had the stones been

(B) The only masonry of this kind we have ever seen was in the walls of Cortona, which are of Tuscan origin,—in the remains of the Castle of Ulysses in Ithaca,—and in the Cyclopian fortresses of Greece. These are probably the most ancient buildings in Europe. It is a circumstance worthy of remark, that the ancient Palaces of the Peruvian Incas are in the same style of masonry, and though the stones of which some of them are built are almost as hard as flint, yet they are so well fitted to each other, that the edge of a fine knife cannot be introduced between the joints, and the seams are but just sufficiently visible to show that the whole wall does not consist of a single stone. (Relacion de Viage del' America Meridional, por Don Jorge y Don Antonio de Ulloa Lib. vi. Cap. xi.

These buildings, as well as those in Greece and Italy, to which we have alluded, are all built without cement of any kind; whether this is the case with the Round Tower of Kilmacduagh we cannot positively say, any more than why this singular, and, we should suppose, difficult and expensive mode of masonry was adopted, in preference to the com-

laid in regular layers in the usual mode, the Tower most probably could not long have maintained its inclined attitude. The churches near this tower are apparently of a more modern date.

The circumstance respecting the Round Towers which most deserves attention, as best pointing out their origin and destination, is this,—that they are always found in the immediate vicinity of a church, or where one is known to have stood. All which have fallen under our own observation, without a single exception, have had a church attached to them, though generally in a state of complete dilapidation. Their position in relation to the church varies, as well as their distance from it; some standing as near as 8 feet, others as far off as 124 feet, and in one or two instances being in actual contact.

The Round Towers, however, are not always of the same date as the churches which stand near them: had they been so, few would have mistaken the obvious purpose of their erection. But they are sometimes, evi-

mon one of squared stones. It may however be observed that when the Greeks, Tuscans, and Peruvians erected those works, they appear to have been in about the same stage of civilization, as the Irish were at the time when we have good reason for supposing the Tower of Kilmacduagh was built.

dently, of a date much anterior to that of the adjoining church,—which has led many to suppose, that they were built for some purpose unconnected with religious uses, and that the churches were afterwards placed near, for the convenience of using them as Belfries. But this supposition, though plausible, is not borne out by facts; for where the churches are of a date subsequent to that of the Tower, they generally display such a perfection of architecture, as to convince us, that men who could erect such buildings need not have had recourse to the Round Towers for hanging their bells. Neither would the Round Towers have suited their purpose, as they are adapted for the suspension of only a single bell, and, in almost all those churches which are of a date subsequent to that of the neighbouring Round Tower, we find the same accommodation for the suspension of a number of bells, as in our own churches in England. It is however possible that in some cases, where the new church has been small, and those who built it poor, they may have been contented with a single bell, and so saved the expence of a new square tower by using the old Round one.

There is however one particular kind of building near which the Round Towers are

most commonly found, which is to all appearance of contemporaneous origin. This is the Stone-Roofed Chapel, and it is, we believe, almost as peculiar to Ireland as the Round Towers themselves.(c) The same rudeness of masonry, simplicity of architecture, and, still more, the singular wedge-shaped and conical stone roofs, are observable in both; and a careful examination will show, that the chapel and its adjoining tower were built at the same time, and are the work of the same hands. These stone-roofed chapels are so very small and dark, as to be inconvenient in the highest degree for public worship; and after the conquest of Ireland, and introduction of the abbeys and cathedral churches which now, whether entire or in ruins, ornament the remotest parts of that country, they fell speedily into disuse, and, with the exception of a few, which still remain perfect, became ruinous, or were destroyed at the reformation. Some were probably wholly taken down, and the present handsome buildings raised on the site; others were taken down only in part, and part was

(c) There are in England some ancient religious buildings with stone roofs, but we believe that none of them are of the same wedge-shape, or bear the slightest resemblance to the Irish stone-roofed Chapels in external character.

preserved and incorporated in the new erection,—of which many instances occur; and some few still remain entire, and stand by the side of the modern church: this is the case with Cormack's chapel at Cashel.(D)

In most, if not in all these instances, the Round Tower belonging to the Stone-Roofed Chapel has been preserved, for some reason, not now perhaps easy to conjecture; possibly, from admiration of its height and singular appearance, or, possibly, from the expence and danger of taking it down.

From those who have attentively examined the subject, we do not anticipate any objection to our position of the Round Towers being of the same date as the Stone-Roofed Chapels, near which they stand. If then they were built at the same time, they must have been erected for some purpose connected with the religious application of the chapels.

(D) Cormack's Chapel is the only instance we have met with of any display of ornament and variety in the stone-roofed Chapels. It is quite unique in one respect: it has a *square tower* at the side and connected with it, about the dimensions of many of the Round Towers, and adapted for the suspension of a single Bell. A Round Tower stands not far off on the same rock, apparently of an older date than the Chapel, and evidently anterior to the remains of a great Cathedral, by the wall of which it is partially enclosed. The Cathedral has a very large square tower for its bells. Probably the Round Tower belonged to some ancient stone-roofed Chapel, *once standing* on the site of the present Cathedral.

Instead therefore of distracting our judgment by attempting to reconcile discordant theories, and fatiguing our attention by wading through the fanciful volumes of Irish antiquaries; instead of consulting even those writers most deserving of credit, we will commence our enquiry about the origin of the Round Towers, by supposing that they had never been described in any history, and that even tradition was silent respecting them:—that we, in short, were the first persons, in whom the sight of these towers had awakened the smallest curiosity. On seeing a high tower standing near a church, and evidently of the same date, we should at once conclude that it was erected for some use connected with the religious application of that church; and on observing near the top of it four arched windows, similar to those in our steeples, the immediate impression on our unprejudiced minds would be, that it was intended for the suspension of a bell, to summon people to worship. This belief would be strengthened by our remarking, that the church itself had no provision for doing this, nor accommodation either for bell or clock, and that one or other, but particularly the *bell*, was absolutely necessary where the population was small, and widely scattered. Our conviction

that such was the purpose for which the tower had been erected, would probably be complete, that no doubt as to its correctness would ever enter our minds, until suggested by one of those antiquaries who delight to refer all objects to the fabulous age, as furnishing a wider field for the excursions of their fancy, the exercise of their ingenuity, and the display of their learning, than that enlightened by regular history. Such men reject the notion of the Round Towers having been built for Belfries, as too simple and undignified, and suppose that they were raised by the *Danes* as Watch-Towers against the natives, admitting, however, that the christian Irish afterwards placed their rude churches near them, and used them for Belfries. This conjecture, for it is nothing more, is quite unsupported by history; and the situation in which many are placed,—those of Glendalough for example,—in a deep valley surrounded by hills, would render some of them at least peculiarly unfit for such a purpose. Neither should we have found two towers standing near each other, had such been the object of their erection, which is quite inconsistent with the fact just stated of the Church and Tower being built at the same period. In speaking of the antiquities at

Holm Peel in the Isle of Man, the author of "Peveril of the Peak" has a passage, which, as it cannot be deemed foreign to our subject, we will take the liberty of quoting,—particularly, as the description conveys a correct idea of the scene presented by almost all the Irish Round Towers.

"There were, besides the castle itself, two cathedral churches, dedicated, the earlier to St. Patrick, the later to St. Germain, besides two smaller churches: all of which had become, even in that day, more or less ruinous. Their decayed walls, exhibiting the rude and massive architecture of the most remote period, were composed of a ragged grey stone, which formed a singular contrast with the bright red freestone, of which the window cases, corner stones, arches, and other ornamental parts of the building, were composed." "There was also one of those singular Towers so common in Ireland as to have proved the favourite theme of her antiquaries, but of which the real use and meaning seems yet to be hidden in the mist of ages. This of Holm Peel had been converted to the purposes of a Watch-Tower."(E)

The whole of this description is so strictly applicable to the Round Towers and churches

(E) Peveril of the Peak, Vol II. p. 62—63.

of Ireland, that we have not the slightest doubt of their being all referable to the same period, the same people, and the same purposes. We have here the modern cathedral of more polished architecture, but now in ruins, and the smaller and ruder churches of an earlier date; and, on examination, one of these at least would probably be found to be of the same age as the neighbouring Round Tower. That this last, situated on a high rock, overhanging the sea, should have been used as a Watch-Tower is natural enough; and had all the Irish Round Towers occupied such commanding situations, it would be perfectly reasonable to suppose that such an application was in part, if not altogether, the object of their erection.

I cannot finally dismiss the above quotation, without expressing my belief, that had the author of Peveril devoted a very small portion of the talent and industry, which have rendered him so eminently versed in the antiquities of his own country, to those of Ireland, he would not have said, that the proper use of these towers "still remains hidden in the mist of ages."

Amongst those who think the Round Towers were Danish Watch-Towers is Peter Walsh, who wrote in the year 1684. Other writers

admit that the Round Towers are coeval with the churches near which they stand, but maintain, that they were not built for *Belfries*, but for "*Penitential Houses*: and the account they give of their application is, that "the penitents were first placed on the top of the tower, when having made a probation of a particular number of days, according to their crimes, they were allowed to descend to the next floor, and so on till they came to the door which always faced the entrance of the church, where they stood and received the absolution of the clergy, and the blessings of the people."(F) Such appears to have been the opinion of Dr. Smith.(G) Mr. Collinson in 1763, in a memoir on the subject, maintains the same idea; and it is further countenanced by an intelligent traveller of the present century, Sir R. Hoare.(H) But we shall require much stronger evidence than any hitherto produced, before we can persuade ourselves that slender towers, 130 *feet high, and perhaps not more than six feet of internal diameter at the summit*, were built for the confinement of penitents. The height of

(F) Sir R. Hoare's Travels in Ireland, p. 280.

(G) History of Cork, published in 1750.

(H) Tour in Ireland, page 284.

the door from the ground presents, we think, an almost unanswerable argument against the Round Towers having been built for the confinement of penitents. In those which have the door 24 feet from the ground, two, if not three stages, are completely lost,—which would never have been suffered, had the object been, by raising the tower so high, to increase the number of the stories. Neither do we see any reason why the seventh story of the penitent's house, which he was to inhabit during his deepest state of guilt, should have four large windows, and the others be provided with only a narrow niche, barely sufficient to admit the light. Mr. Harris and Dean Richardson suppose the Round Towers to have been the residence of Anchorite Monks, or a kind of Pillar Saints, like those we read of in the East.(1) And to complete the catalogue of amusing conjectures, the author of the Collectanea,(K) determined to surpass every competitor in the novelty of his theory, derives the model of the Round Towers from the Persian Fire-temples, and supposes them

(1) History of Simeon Stylites.

(k) General Vallancey. He says. "The pyramidal flame seems to have given the idea of the Round Towers, which were conical and ended in a point at the top both in Hindostan and in Ireland.

Collectanea, Vol. vi, p. 123--156.

to have been erected for a similar purpose. We do not think it necessary to attempt any refutation of the two last conjectures, as they have no foundation either in history or tradition, nor indeed in the nature and appearance of the Towers themselves.

That a high Tower, with four apertures or windows at the top, standing near a church, which has in itself no provision for calling people to worship, should have been designed for a Belfry, is surely a more probable supposition than any of those we have just quoted: it is moreover the natural and obvious conclusion to draw, which strong evidence only ought to invalidate; and it seems to us that the *onus probandi* rests with those who deny its correctness. Lest, however, it should be said that our notion, though a probable one, is yet nothing more than a presumption, we shall proceed to adduce some direct evidence in its favor.

The stone-roofed chapel at Glendalough, called the Ivy Church, has a Round Tower, which, instead of being separated from the main building as in most instances, is affixed to it, or nearly so, in the same manner as modern steeples. In another stone-roofed chapel at the same place, called St. Kevin's Kitchen, a Round Tower is actually *raised upon* and *rises*

from the roof of the church. This is no modern addition, but an essential part of the original building; and if this was the steeple, as we think no one can deny, the adjoining one, differing from its neighbour in nothing except the single circumstance of its being raised at the side, instead of on the roof of its church, must have been erected for a similar purpose. The third Round Tower (for Glendalough boasts of three) is, like most others in Ireland, built at some distance from its church; but corresponding in other respects with the two just described, we cannot in candour assign to it a different origin. These three Round Towers, which are so near each other as to be all comprehended in one glance of the spectator, form the connecting links between the perfect steeple and perfect Round Tower.

In one Round Tower, if not in more, the oak beam remains, from which, in all probability, the bell was once suspended. "That of Ardmore," says Smith in his History of Waterford, published in 1746, "was used for a Belfry, there being towards the top not only four windows to let out the sound, but also three pieces of oak still remaining on which the bell was hung: there were two channels cut in the sill of the door,

where the rope came out, the ringer standing below the door on the outside."(L) From the impossibility of ascending any of the Round Towers, we cannot say what indications, or if any, there may be, of beams on which the bells were hung. If the upper parts of them were to undergo a thorough examination, the result would be of much use in deciding the question.

Giraldus Cambrensis, who wrote so early as the year 1185, a few years after the conquest of Ireland by the English, and from whom we have the earliest authentic information about that country, describes the Round Towers as "Turres Ecclesiasticas, quæ, more patrio, arctæ sunt et altæ, teonon et rotundæ." Ecclesiastical Towers—which, after the fashion of the country, are narrow, high, and round. This is not, it must be allowed, historic evidence, that the Round Towers were used for Belfries, but it is, that they were then used for some purpose connected with the church.

But one important fact is to be found in most of the writers on Irish antiquities, whether they attribute the Round Towers to Christians or Heathens, Irish or Danes,—which is, that the common name for them amongst

(L) Ledwich's Antiquities, 168.

the natives was *clochtheachs*, or *bloghachd*, that is, literally *Bell-Houses*.

Dr. Molyneux, who wrote in 1727, (M) remarks on this subject "That the Irish word *cloghachd* is taken from a foreign tongue, and, being a term of art, imports the thing it signifies, must likewise be derived from foreigners. Now the Irish word does plainly owe its etymology to *Clugga*, a German Saxon word, that signifies *Bell*, from whence we have derived our modern word Clock. This appellation also shews the end for which these Towers were built, for *Belfries or Steeples*, wherein was hung a Bell to call the people to religious worship."

We have now shown both from the nature of the buildings themselves and their connection with the neighbouring churches, and from the evidence of the most ancient and respectable Historian of Ireland, that the Round Towers were built for some religious use. We have shown also, that the common name amongst the native Irish for these Towers was, and indeed we believe still is, *Bell-house*. And we have seen moreover, that instances are not wanting, where the Round Tower passes into a perfect Belfry, and that in some, the beams remain on which the Bell

(M) Boates and Molineux's Nat. Hist.

was actually hung. If we consider, in addition to these facts, that the other hypotheses respecting the Towers are either in themselves highly improbable, or unsupported by history, we think that little doubt will remain on any unprejudiced mind of their real destination and use.

That they were built for Belfries, and applied to that purpose, and *that alone*, appears to us so evident, that we should not have entered so much at length into the subject, were we not aware how many respectable writers have differed on the subject, and how few persons amongst our acquaintance are disposed to admit our conclusions.

Let us now enquire for a moment when and by whom these singular Towers were erected.

Christianity was introduced into Ireland early in the 4th century, and monasteries established in the 5th.

About the middle of the 9th century, the invasion of the Danes, or Ostmen, as they were called, took place.

Till they arrived, it is confidently asserted, that the native Irish had no building of stone, (N) and most probably they had none of importance. The stone-roofed chapels, build-

(N) See Ledwich's Antiquities of Ireland.

ings of rude and simple, but in some respects of curious construction, are the most ancient regular edifices in Ireland, and they are almost universally attributed to the Ostmen, or Danes: the Round Towers, therefore, which as we stated before are generally attached to these buildings, and bear evidence of being of the same date, were the work of the same people. They were erected some time between the period of the invasion of the Ostmen, and the conquest by the English:—that is, between the 9th and 12th century, when the superior style of building immediately no doubt superseded the use of the *existing* stone-roofed chapels, and prevented the *farther erection of them*, as the introduction at the same time of the modern steeple superseded the use of the Round Towers. Dr. Smith, on the authority of an Irish manuscript containing the annals of Munster, states, that the Round Tower of Kenith, in the County of Cork, was built in the year 1015, (o) which date agrees with our supposition.

Many of them however, and probably the greater part, were built before the Tower of Kenith, for Cormac's chapel and square Tower, if we may judge from the rich and superior style of architecture, is of a subsequent

(o) Hoare's Tour in Ireland, p. 280.

date to most of the stone-roofed-chapels of Ireland, and probably also to the Round Tower standing near it; and yet Cormac, the founder of the above chapel, was slain in battle so early as A. D. 908.

We should therefore attribute the origin of the greater part of the Round Towers to as early a period as the 9th century.

That the Round Towers, if Belfries, should not be joined to their respective churches, cannot be regarded as very extraordinary, since there are many instances, both in England and on the continent, of their separation; indeed the union of two buildings, intended for such different purposes as a Church and a Belfry, seems rather a refinement in architecture, and some skill is necessary to combine them in an easy and elegant connection.

It is not so easy to account for the *shape* of the Round Towers, and we know not from what model it was copied, or how suggested to the architect. In such rude times we should rather have looked for *square towers*, as simple in structure, and of more easy erection; and we find that this form has generally been adopted throughout Europe. The celebrated leaning *Tower of Pisa*, however, is round, and most, if not all, the *Minarets* of the Turkish Mosques are round.

Possibly this form may have originated in the fancy of the first builder of them, or possibly he might have been aware of the superior strength of the round form, and preferred it on that account.

We have been told that there are Round Towers in the north of Denmark, but, from the description given of them, they seem to be of a totally different character from those in Ireland. They are built along the coast at regular intervals, on eminences, in sight of each other, are capable of containing a great number of armed men, and are evidently placed there for resisting an invasion.

It certainly is a singular circumstance, if the Ostmen were in fact, as they appear to have been, the first builders of the Round Towers, that no similar ones should be found in their *own country*, which, we believe, cannot boast of *any*. Of this no satisfactory explanation has been given, and that which we offer rests wholly on conjecture. The native Irish had been Christians for nearly five centuries before the invasion of the Ostmen. They must have had some kind of churches for public worship, and these, it is generally admitted, were then built of wood. They must also have had some means of summoning their congregations to the church: how

they accomplished this before the introduction of bells, we do not know; but when these were introduced, probably a century or more before the Ostman invasion, they must have invented some mode of *hanging* them. Their first Belfries, like their churches, were of wood, and for some reason now unknown the round form was adopted. The Ostmen, who introduced the art of masonry, perhaps merely imitated in stone what they already found existing in wood, so that though the Round Towers were *built by them*, their *form* was borrowed from the Irish. This would account for none of these towers being found in Denmark, and that there is so little trace of them, if indeed any, in England. In *Scotland* there are two, those of Brechin and Abernethy; but the communication between that country and Ireland was intimate in early times, and the plan of *these*, as well as the one at Holm Peel, was probably introduced from Ireland, or they were built by some colonies of Irish settled at those places.

The stories, or floors, in the Towers were most probably for the convenience of ascending to the bell, when necessary; indeed, without the intervention of such stages, we do not see how it would have been possible to attain the summit. In none we have ei-

ther seen or heard of, does there exist any appearance of stairs; neither should we think it probable, that in those early times architects could have been found in Ireland, capable of constructing circular stairs, and those too in so narrow a building.

The bell was probably not rung, but struck with a hammer, as was formerly the case with most, and is still with very large bells.

In placing the door so high above the ground, *security* could have been the *only* object, whether the thing to be secured was a feudal chief, a penitent, or a bell. Bells in those times were scarce, and perhaps locks no less so, and for safety, or, still more, to prevent unauthorised persons from ringing them, the door was placed at such a height as to be accessible only by a ladder. There are only one or two instances of the door being sufficiently low to enter without such assistance.

We are not aware of any other particulars which require explanation, or which are of sufficient importance to merit observation. We have now stated at some length our opinion respecting the origin and use of these Round Towers, and given the principal reasons which have led us to the conclusion, that they were erected and used for Belfries.

Should our arguments have appeared decisive to any who have hitherto regarded these buildings as of unknown date and unintelligible application, and should we have thus destroyed their poetic associations, and put an end to their amusing speculations, they will perhaps excuse us for having substituted in their minds certainty for doubt, facts for theory, truth for error. If their previous opinions have not been shaken, they may by our arguments still continue to regard with pleasing, though undefined wonder, these records of the olden time, to exercise their skill in defending the theories of others, or their ingenuity in forming new ones of their own. To those who have embraced no particular theory, and whose minds have not been prejudiced on the subject, we flatter ourselves that the opinion we have maintained will seem the most probable one, and that they will yield their assent to it, until some other supposition, more reasonable in itself, or supported by stronger evidence, be produced in its stead.

If our time permitted, and the nature of our subject authorised such a digression, we might perhaps show, that though some old associations may be destroyed by admitting our theory respecting the Round Towers,

new ones may be formed as legitimate, and perhaps no less pleasing.

We have not attempted to prove that they are the creatures of yesterday—that they were built by our contemporaries, or by our immediate ancestors. A thousand years have rolled over their heads,—ten thousand storms assailed their summits,—yet they remain still unshaken in their adamantine strength, or, still "*majestic in decay.*" It is true, we have shown that they are not of Pagan origin: but can this be matter of regret to a Christian? From their hollow precincts, issued perhaps the first sweet sounds of the Sabbath-bell, which, echoing from hill to hill, summoned the wild savages from their rocks and woods, to join in social worship, to hear the blessed tidings of the Gospel of Christ, and to learn that they were endowed with a nobler nature, gifted with higher powers, and born to a richer inheritance than the "brutes which perish."

The simple churches, built before the Papal usurpations, which saw the erection of the Round Towers, are most of them gone for ever, and the rest fast mouldering into dust. The magnificent structures which succeeded, the pride of the sons of Rome, are now also in ruins, and must soon follow their ruder

predecessors. But the Towers themselves seem destined to survive the wreck of time; and having excited the wonder, and awakened the curiosity of generations now no more, promise to be the theme of poets and antiquaries, amongst generations yet unborn.

APPENDIX

TO THE

ESSAY ON SALT RAIN,

(page 324)

WITH ADDITIONAL OBSERVATIONS

On the succeeding Storms of Wind and Rain.

BY JOHN DALTON, F. R. S. &c.

(Read March 21st, 1823.)

AT the time the Essay above mentioned was read to the Society, I had no opportunity of consulting records for accounts of similar phenomena. Since that time I have looked into several works, but have not met with more than one or two relations of the same kind. These are to be found in the Philos. Transact. 1704. (See abridgement by Dr. Hutton, &c., vol. 5, page 19.)

The first is entitled "A strange effect of the late great storm in Sussex, by John Fuller, Esq. in a letter of Dec. 6th, 1703," and is as follows:

"We live ten miles from the sea in a direct line, and yet cannot persuade the country

people but that the sea water was blown thus far, or that during the tempest the rain was salt; for all the twigs of the trees the day after were white and tasted very salt, as I am informed almost by every body, though I did not taste them time enough myself, nor observe it; and that not only upon this hill where we live facing the sea, but in all other places within 14 or 15 miles of the sea, as well as in the valleys, between which and the sea are several very high hills, as on the hills themselves."

This account of Mr. Fuller is followed by one of Mr. Derham of Upminster, Essex, respecting the same storm, which seems to have occurred in its greatest violence in the morning of the 27th Nov. 1703. Mr. Derham, after briefly describing the weather for several months preceding, adverts to the recent storm, which by the best estimate he could form, exceeded any previous one for five or six years, in regard to the *velocity*, or rather perhaps the *force* of the wind, in the ratio of 3 to 2.

The concluding paragraph runs thus: "I have just received an account from a clergyman, an intelligent person at Lewes, in Sussex, not only that the storm made great desolation thereabouts, but also an odd cir-

cumstance was occasioned by it, viz.—'That a physician travelling soon after the storm to Tisehyrst, about 20 miles from Lewes, and as far from the sea, as he rode he plucked some tops of hedges, and chewing them he found them salt. Some ladies of Lewes hearing this, tasted some grapes that were still on the vines, and they also had the same relish. The grass on the downs in his parish was so salt, that the sheep in the morning would not feed till hunger compelled them, and afterwards drank copiously, as the shepherds report. This he attributes to saline particles driven from the sea.' "

Immediately after this follows an account of the same storm, as observed in Holland by Mr. Leuwenhoeck, whose residence was, I believe, at Delft in Holland, about 10 miles from the sea. Part of the account is given as under:

"Upon the 8th December, 1703, N. S. we had a dreadful storm from the S. W. insomuch that the water mingled with small parts of chalk and stone, was so dashed against the windows, that many of them were darkened with it; and the lower windows of my house were not opened till eight that morning, notwithstanding that they look to the N. E.; and consequently stood from

the wind, and though guarded from the rain by a kind of shelf or pent-house over them, were yet so covered with the particles of the water which the whirlwind cast against them, that in less than half an hour they were deprived of most of their transparency. Supposing this might be the sea-water which the storm had not only dashed against our windows, but spread also over the whole country, I viewed the particles with my microscope, and found they had the figure of our common salt, but very small, because the water was little from whence those small particles proceeded; and where the water had lain very thin upon the glass, there were indeed a great number of salt particles, but so exceedingly fine that they almost escaped the sight through a very good microscope.

But as to the upper windows, where the rain had beat against them and washed them, there was little or no salt to be found sticking upon them."*

* The storm above described appears to have been the most violent and destructive perhaps of any during the last century. There was a pamphlet published on the occasion, by some one of talent and observation. (See copious extracts from the same. in Howard's Meteorology, Vol. 2. page 311.) It was calculated that 25 parks lost 1000 trees each, and the New Forest, Hants, above 4000. Seven steeples, above 400 windmills, and 800 dwelling-houses, were blown down in England and Wales. About 120 persons lost their lives, amongst whom were the Bishop of Bath and Wells, and his Lady. It was on that memo-

In my former paper I mentioned my having collected from my gage, the rain water which fell on the 5th December, and examined it in regard to muriatic acid, when it was found to contain a certain portion: also, that the next rain which fell after the 5th December, when there was no remarkable wind, was also examined, and found to contain muriatic acid, but much less than before, namely, about $\frac{1}{7}$. This last I was led to ascribe to the glazing of the earthern bottle.

Since that time I have had an opportunity of examining this conjecture more fully. I filled the gage bottle with distilled water, and let it remain in the bottle three days, (the time the rain water on the 5th December remained in the bottle) and then subjected it to the usual tests. It manifested traces just sensible of both muriatic and sulphuric acid; but the quantities were infinitely less than I had found in the rain water of the 5th December.

rable occasion, that the Eddystone Light-house was blown into the sea, with the Engineer who had erected it, and who had promised himself that it would bid defiance to the elements.

A vessel that broke from her moorings, was driven at the rate of 30 miles per hour, for 8 hours successively.

This storm continued for a week, so that the wind might be said to blow a hurricane each day, though the extreme violence which produced such effects was limited to about 12 hours, as usual on such occasions.

About the same time Mr. Blackwall brought me a quantity of rain-water which he had collected in a clean glass vessel in calm weather. It was scarcely to be distinguished from distilled water, being unaffected by muriate of barytes, nitrate of mercury, and as nearly as possible by nitrate of silver. The same remarks apply to a quantity of water which I procured from some recently fallen snow. These facts demonstrate that in ordinary circumstances the rain is destitute of salt, except we may find an infinitely small quantity from the effluvia of burning fuel, which in a large town may possibly become sensible in the rain falling through the atmosphere, and carrying along with it particles of muriate or sulphate of ammonia.

On the 24th Feb. we had another storm of wind not much inferior in force to that of the 5th December. This too was accompanied with rain, and from the S. W. or W.—The rain, a little diluted with what fell subsequently, was taken from my gage and examined. It indicated .55 parts of a grain of salt in 7500 of water. A specimen which Mr. Blackwall favoured me with from his gage the same day, contained 88 parts of a grain of salt

in 7500 water. My gage water exhibited a trace of sulphuric acid, Mr. Blackwall's none.

Another storm of wind and rain succeeded this, on the 4th March. The wind was chiefly from the west, and extremely violent in the night; and on the morning of the 5th several slates were blown from the roofs of houses. Next day the windows were visibly covered with salt. I collected from two squares of glass, salt sufficient to saturate 10 grains of a solution of nitrate of silver of 1.01 sp. gr. A portion of magnesia sufficiently visible was precipitated by lime water.

My rain-gage water, but somewhat diluted with succeeding rain, yielded for 7500 grains, .27 grain of salt, and manifested sulphuric acid. Mr. Blackwall's rain-gage water indicated for 7500 grains, .33 grain of salt, also a trace of sulphuric acid. Mr. Blackwall also collected a portion of rain in a clean glass vessel during the most violent period of the storm. This water indicated for 7500 grains, 1.66 grain of salt, which is the largest proportion I have yet found, excepting that from the tub in the Society's yard, which I have already observed is probably not a fair specimen. This portion of water

collected in glass also gave a very minute trace of sulphuric acid.

Finally, I examined my rain-gage water collected from the 9th to the 16th of March, fallen in ordinary circumstances, and found it to yield a very sensible trace of sulphuric acid, but scarcely any of muriatic acid. The sulphuric acid is chiefly due, I apprehend, to the earthenware bottle of the gage. I have on one or two occasions collected rain water in the town in clean glass vessels; it gives no trace of sulphuric acid, but generally a slight one of muriatic acid, which however is infinitely short of what has been shewn in the waters above mentioned on the occasion of storms. It is owing, I apprehend, as has been observed, to the muriate of ammonia, sublimed by the combustion of coals, and mingled with the atmosphere, which is carried down again by the rain.

If we calculate from the last specimen of water furnished by Mr. Blackwall, it would appear that $\frac{1}{1000}$ part of the water which descended during the most violent period of the storm, March 4th, was sea-water, which had been brought mechanically by the wind for the distance of at least 30 miles. How much further it may be carried on such occasions we have not observations at present

to determine; neither have we data to ascertain what is the least velocity of the wind which will bring it to this distance from the sea.

From what has been advanced, it may be presumed that the fact of sea-water being occasionally carried by the force of the wind many miles into the interior of a country, cannot be doubted. We have further ascertained in a certain degree the *proportion* of sea-water which may be expected in rain-water on such occasions; this may be of use as a term of comparison for other times and places. It remains to make a few observations upon the utility likely to attach to this investigation.

It is a well known fact that sea-air has a powerful influence on the animal and vegetable creation. Certain diseased constitutions are greatly improved by it; others are injured in nearly the same degree; yet chemists have not hitherto been able to distinguish air collected over the midst of the Atlantic ocean, from that brought from the interior of a continent; nor town air from country air. Now if the spray from the foaming waves be liable to be wafted away to a considerable distance by the breeze, even in the driest state of the atmosphere there must be particles of salt floating

about in it; for, the *water* resolving into *steam* will desert the salt; and this being found in infinitely fine particles, will be so much the less inclined to descend, and may be carried even farther than the sea-water, in consequence of the particles being of superior tenuity. If this reasoning be correct, sea-air, whether immediately over the sea or on the coast, will scarcely ever be entirely free from salt, either in rainy or fair weather; and hence we are led to perceive what is most probably the cause of the sea-air being salubrious to one constitution and insalubrious to another. May not the diseases incident to a sea-faring life, and even sea-sickness itself, be more or less ascribed to the slow but incessant operation of this modification of the atmosphere?*

* Happening to be at Leeds on the 5th December, 1823, there was in the night and ensuing morning, a violent storm of wind and rain, scarcely inferior to that of December 5th the preceding year. The wind too was from the S. W. and W. I took the opportunity to examine the rain caught in the gage kept by order of the Philosophical and Literary Society of that place. I could find no trace of muriatic acid in the water, more than might be expected from the combustion of coal in so large a place. Hence it would seem the extent of that storm, as far as regards the salt rain, was limited.

SOME REMARKS

ON THE

NATURE OF GENIUS.

BY THE REV. JOHN JAMES TAYLER, A. B.

One of the Secretaries of the Society.

(Read October 31st, 1823.)

O Lacrymarum Fons, tenero sacros
Ducentium ortus ex animo; quater
Felix! in imo qui scatentem
Pectore te, pia Nympha, sensit.
Alcaic Fragment of Gray.

THERE are few questions, on which the love of paradox has not led ingenious men to start opinions different from those which are usually entertained. Some accordingly have undertaken to deny the existence of any original difference in the faculties of the human mind; and have ascribed the endless varieties of character and gradations of talent observable amongst men, to the diversified influence and excitement of education and circumstances. To this view of the subject, the general persuasion of mankind, which is certainly corroborated by obvious appear-

ances, is decidedly opposed. Certain traces of originality, earnestness and vigour, in an individual's mode of thinking or acting, seem to indicate something of a superior nature in the very structure of his mind; and however vague the language of people on this subject may usually be, we shall find, I apprehend, upon examination, there are some peculiar qualities of mind understood in every character to which the term Genius is applied.

To point out these peculiar qualities of mind, to collect them into one view, and enquire whether they cannot be resolved into some common and fundamental principle, is the object proposed in the following Essay.

Here a difficulty meets us at the outset. What is meant, it will be asked, by Genius? a word, it must be admitted, which excites no very distinct idea in the mind. But, in fact, the subject to be investigated is of so vague a nature, that we shall be under the necessity of using, for some time, a term which we cannot previously define, and the meaning of which will then only become precise and distinct, when we have pursued it, like the unknown quantities of the algebraist, through various forms and changes, and brought our examination to a close.

It is seldom of much service in the investigation of metaphysical ideas, to apply to the etymology of the abstract terms by which they are expressed; nor do I now recur to the origin of the word Genius so much for the sake of shewing what it means,—as in order to procure something like a fixed point, on which to hang our subsequent enquiries—and also to trace rapidly the process, through which it seems to have passed into its present signification. Genius—is a Latin word; and, by its derivation, should mean what is born with us.(*a*) Hence it usually denotes the tutelary spirit, who was supposed by the ancients to preside over the birth and govern the life of every one. By a refinement of abstraction, they separated, as it were, the individual from his moral and intellectual character; which they invested with an independent existence, and supposed to control his destiny. To the elegant fancy of the Greeks, even the objects of inanimate nature and particular spots, which were marked by a certain solemnity of aspect, seemed under the influence of some protecting deity; and we find the heroes of antiquity

(*a*) Est autem Genius naturalis vel loci, vel rei, vel hominis cujusque Deus, *quasi nobiscum genitus.*

Schulting. in Quinctil. pro caco Declam. I. p. 32. edit. Burm.

occasionally offering their vows to the GENIUS of the unknown regions they had entered. *(b)*

The same liveliness of imagination which made the ancients people every element with gods, and deify every operation of nature, led them on to a personification of the most abstract ideas,—to an apotheosis (for in fact it was so) of character: hence their conception of a Genius, or presiding deity of places and of men. To the Genius which ruled the moral and intellectual man and disposed the events of life, every thing remarkable in the circumstances of the individual was attributed; to the same influence was referred every peculiarity of disposition, every superiority of talent. I need only allude, for an illustration of these remarks, to the well known case of the Genius, or Dæmon, by which Socrates professed to be controled in his actions; and the classical scholar will immediately remember the lines, in which Horace resolves the question, why men are born into the world with such different propensities, by ascribing them to the various influence of the tutelary

(*b*) So Æneas, on landing in Latium—

———GENIUMque loci, primamque Deorum
Tellurem, Nymphasque, et adhuc ignota precatur
Flumina.

Æn. VII. 136.

See also Æn. V. 95. with Heyne's note.

Spirit.(c) Sometimes, but more rarely, without reference to the idea of a deity, the strong inclination of an individual for any pursuit, and the characteristic qualities by which he was strikingly distinguished from others, were called his *genius*. This latter signification the word still retains with us, who have borrowed it from the Romans. It denotes the strong bent of the mind. When a person discovers an ardent passion for some art or science, and a consequent aptness to excel in it, he is said to have a genius for it. Hence it is used, by an obvious extension of meaning, to signify that natural quickness and vigour of intellect which enables its possessor to surpass other men in any pursuit to which he may devote himself. Such is a loose description of the word Genius, and of the way in which it seems to have acquired its present general meaning: and we must now briefly enquire what are some of those characteristic qualities of mind, which appear generally to be implied whenever the term is used.

(c) Scit GENIUS, natale comes qui temperat astrum,
Naturæ deus humanæ, mortalis in unum
Quodque caput, vultu mutabilis, albus et ater.
2. Epist. II. 187.

Very nearly the same sentiment is expressed in a fragment of Menander quoted by Cooper in his Life of Socrates, p. 90.

Among the foremost of these qualities we may specify great vividness of conception; by means of which an individual is enabled to present his ideas in a very strong light and definite shape, so that the sentiment or emotion, which he means to convey, may be at once apprehended, and seem to come fresh and glowing from the mind of its author. Again, it is characteristic of Genius to be extremely earnest and enthusiastic in the pursuit of its object, and to seize with instinctive quickness every association, which has a relation to it, which places it in a clearer point of view or invests it with new grandeur and beauty. A still stronger indication of this mysterious faculty is discovered in a certain originality of thought and freshness of feeling, the absence of which we censure in works of art, when we call them *mediocre* or common-place. In an enquiry of this nature, it is difficult to avoid falling into vague and unmeaning declamation; but those, who are capable of feeling what is striking and beautiful in works of art, will understand me, when I observe that, in the productions of real Genius, there is a peculiar newness and integrity of expression, which distinguishes them at once from the effusions of inferior minds. It is as though

the nursling of Melpomene (*d*) had wandered through the pathless haunts of the Muses, untrodden as yet by human foot: and spurning the withered garlands, which had been soiled in other hands, had culled a wreath for his brow of fresh flowers, still dripping with the dews and fragrant with the sweets of Castaly.(*e*)

Wherever then we apply to a writer or an artist of any description the term Genius—if we analyze the impression, which the word leaves upon the mind; we shall find it, I apprehend, involve the idea of the three circumstances before enumerated; vividness of conception; enthusiasm of purpose; and originality, or what may be called freshness of sentiment, which is occasioned by his mind's perpetually discovering new relations between its ideas, and which awakens, in its expression, a peculiar interest and delight. The man of Genius, if we may judge by the transcript which he gives of his impressions, looks at nature, as we may say, with an eye of his own. He surveys every object, under the influence of some reigning association, which gives an individuality of character to his mind; and not through the medium of

(*d*) Hor. Carm. IV. 3 (*e*) Lucret. IV. 1—5.

those vulgar and hacknied associations, which are imparted to all men by a common education, and which have ceased, from their incessant recurrence, to excite any emotions of pleasure. Hence his enthusiasm is warm and susceptible, and derived from a source within himself. The originality of his mind, which is one essential constituent of his Genius, does not indeed reject the conceptions nor is insensible to the emotions of other men; but before such conceptions and emotions can be admitted to take up their abode in his own mind, they must harmonize with his previous sense of what is just and beautiful; they must be *felt* like his own; and by being *felt*—by being incorporated with his own primitive stock of imagery and sentiment, they preserve the same freshness and originality of character, as if they had not been derived from any foreign source. Some of the choicest passages in Virgil, Spenser and Milton are imitations; yet they have not one feature of the *common-place.* The imagery, which those illustrious poets borrowed from their predecessors, was so wrought into their minds, that it formed a consistent whole with their native conceptions, and was poured forth with them from the heart in one mingled tide of inspiration.

There must be enthusiasm in a writer himself, to produce an impression on his readers; and enthusiasm is most likely to be excited, where the conceptions are strong and vivid. Where again the conceptions are vivid, the associations of ideas will be various and extensive, rapidly connecting themselves with every object in the whole sphere of thought and observation. In this richness of association, we discover another token of Genius.(*f*)

(*f*) There is perhaps no period of our Literature, in which this richness of association is so conspicuous as in what is called the age of Queen Elizabeth, though in fact embracing a considerably longer space than the reign of that Princess. One reason may be, that our language had not acquired that power of abstract and philosophical expression, which it at present possesses. Hence writers of all descriptions, in prose as well as in poetry, were under the necessity of recurring to figures and similitudes, in order to convey the full force of their ideas. Language is the vehicle of thought; but thought, during this period of our literary history shot forth with such vigour and rapidity, as to outgrow the capacity of its habitual vehicle; and it was some time before this disparity could be adjusted. Hence men resorted, in their necessity, to the original source of all ideas however abstract, the world of sense and matter; and helped out their intellectual deficiency by means of metaphors and comparisons. Witness, for example, the writings of Lord Bacon. I cannot but think this vigilance to detect analogies between the natural and the moral world, this habit of presenting truth in a picturesque and emblematic form to the mind's eye—must have tended to encrease the vividness of the conceptions and multiply the associations, however unfavourable it might generally prove to clearness and depth of reasoning. Nor should the influence of the Masques and Pageants be forgotten; which accustomed the mind to contemplate the truths of religion and morality through the medium of images addressed to the eye, and must have given a peculiar distinctness to the conceptions, and a figurative expression to the language, of all classes. From this extreme vividness of

Take any acknowledged man of Genius then; take the greatest of painters, of musical composers, of dramatists, orators or poets;—consider what are the qualities of mind, as expressed in their works, which have raised them to this high distinction amongst men; and see, whether it be not to a certain force of conception, to an originality and variety of sentiment—and, more than all, to an indescribable spirit of enthusiasm, which reigns through their productions, and marks them for the spontaneous overflowings of a redundant fancy—whether it be not to some or to all of these qualities that they are indebted for the high and honourable title of men of Genius. There may, it is true, be unknown wonders in the bosoms of these highly gifted beings—those *penetralia* of the soul, "where no profaner eye may look;" but the qualities, which I have enumerated, must strike the observation of every one, and enter essentially into the meaning of the word Genius.

It has sometimes occurred to me, that these peculiarities, which are indicative of Genius, when we consider the almost infinitely diversified influences of association,

conception the Literature of Elizabeth's age derived its wild, luxuriant and imaginative character. But the reign of Elizabeth is almost proverbially the age of English Genius.

may be resolved into a strong original susceptibility of temperament—or, in other words, a livelier perception, than is granted to men in general, of pleasure and pain.(*g*) The first statement of this idea may wear an air of paradox; yet it is an obvious extension of Mr. Locke's theory of the human mind, which carries back the origin of all our ideas to sensation and reflection, and I hope to shew in the sequel that there at least some plausible grounds for entertaining it.

The power of distinguishing between pleasure and pain is an ultimate fact in the human constitution; it is original, innate and incapable of analysis. It is the earliest func-

(*g*) I am aware, that in explaining the original differences of character, we ought perhaps, in philosophical correctness, to consider this acute sensibility to pleasure and pain, rather as consequent upon a constitutional susceptibility of temperament than identical with it. —But I am not prepared to go deep into physiological disquisition, and wish to confine myself to the metaphysical view of the subject. By what peculiar organization of the bodily frame this constitutional susceptibility is occasioned; how far it involves an extraordinary acuteness in each of the five senses; or whether it does not chiefly depend on the liveliness of that more general sense, which is diffused, under the name of feeling, over the whole body; I hardly consider it within my province to inquire. With the impressions, which are received through the senses in the commencement of existence, and none of which probably are in the first instance indifferent, it is to me perfectly conceivable that various degrees of pleasure and pain, dependant on the different bodily organization of individuals, may be connected. If this be granted; I ask no further concession, as the basis of the subsequent theory.

tion, which man is called to exercise, existing perhaps in the womb. It is the final motive of all his actions; it is the basis of all his associations; and exerts an influence on the most refined of his sentiments and the most excursive of his thoughts. Analogy renders it in the highest degree probable, that all our perceptions were accompanied originally by a sense of pleasure and pain, and have become indifferent only by long-continued repetition. It is this capacity of discriminating the pleasurable from the painful, which constitutes man a moral agent; which gives him an interest in the world which surrounds him, and forces him into action.

Let us conceive, if it be possible, of a being capable of receiving impressions from external objects, but destitute of all sensibility to pleasure and pain. Such a being, as he would want all intelligible motives of action, must continue inert and motionless, nor could answer one conceivable end of existence. Give him a sense of pleasure and pain, and you supply him at once with the springs of activity, and set his moral and intellectual machinery at work.—This is so completely the case, that, *cæteris paribus*, we may safely affirm, the ardour of his labours and enter-

prize and the acuteness of his intellect will be just in proportion to the strength of his desires and aversions. Upon this theory then, it may be asked, wherein is the superiority of man over the brutes; some tribes of which possess the natural passions in equal, if not in greater force than the human race? I answer, in the power of associating and generalizing his ideas, which man exercises to an almost boundless extent, but which the most sagacious brutes possess only within a very limited sphere.(*h*)

On the strength, vividness, variety and extent of associations depends, as it seems to me, the great intellectual superiority of one man over another; and it may be shewn, I think, that the strength of our associations will be materially affected by the greater or less degree of susceptibility in our original constitution. It is very much the practice of philosophers, in the present day, to explain the various operations of the mind by means of association. But, in most cases, this is only throwing the difficulty one step

(h) Brutes cannot carry on a long train of general reasoning, because their associations embrace a comparatively small number of ideas, and seldom extend far beyond the objects of direct bodily sensation. But within that narrow circle, they often reason with very great acuteness, as the dog, for example, when lost, in searching for his master; and perhaps from this very circumstance, that their sensations are exceedingly keen and are concentrated on a very few objects.

further back in the investigation. The pleasurable or painful association, by which our minds are, on any occasion, affected, is itself dependent on a previous association; that, on a former one; and so on, the extent of the association being reduced at every step; till at last we must come, as I conceive, to that, which is the germ and nucleus of the whole system,—the radical impressions of pleasure and pain, received through the senses in earliest infancy. What are our moral sentiments, when pursued through the various ramifications into which they are spread, but certain strong and permanent associations with those radical perceptions of pleasure and pain,—of happiness and misery,—acquired, in the first instance, through the medium of the senses? The *rectitude* of our moral sentiments will depend on the bias given to the mind by education; but the *strength* of them—all that makes us feel deeply and conceive forcibly and act resolutely—must arise from a strong association of pain and misery with one mode of conduct—of pleasure and happiness with another. The predominant association, which gives a tone to the sentiments and determines the character, may have been produced by accident; but its influence, when formed, will depend on its strength;

and its strength, if we ascend to the source of all our associations, will be derived from a more than ordinary acuteness in the original susceptibility of pleasure and pain. We may state the case in a few words thus. The *primum mobile* of the moral constitution of man—the central spring, which puts his faculties in motion and urges him to action—is a discriminating sense of pleasure and pain. Upon this primary distinction in our original perceptions, are founded all those subsequent associations, however remote or extensive, which influence our conduct and govern the train of our thoughts. The more powerful the cause, the stronger the effect: our associations will then be most vivid, when the sensations of pleasure and pain connected with them, and on which they ultimately rest, are most acute. We know what is the effect of very strong excitement upon men of ordinary talents. When some vivid association has taken possession of their minds, they seem to acquire a force and energy of character quite beyond their usual capacity; and, while the excitement lasts, they conceive, combine and arrange their plans with a fertility and promptitude—they act with a decision—and speak with a warmth and eloquence—which are the prerogatives of spi-

rits of a far higher order. But when this susceptibility of excitement is the gift of nature—when it continues through life to influence the whole range of our associations—it then becomes the cause of what we call Genius.(*i*)

(*i*) Akenside has beautifully described the effect of very strong excitement on the mind; Pleasures of Imagination, Book II. 137, &c.

> The flame of passion, thro' the struggling soul
> Deep-kindled, shows across that sudden blaze
> The object of its rapture, vast of size,
> With fiercer colours and a night of shade.
> ——— Then nature speaks
> Her genuine language, and the words of men,
> Big with the very motion of their souls,
> Declare, with what accumulated force
> The impetuous nerve of passion urges on
> The native weight and energy of things.

The case of nations resembles that of individuals. In those states of society, which furnish the strongest excitements, we usually find the greatest development of Genius. Hence it rarely attains to maturity under a Despotism, but thrives with uncommon vigour in a Republic. Longinus, (de Sublim. Sect. 44) while he expresses a doubt whether slavery be not fitter for his degenerate contemporaries than liberty, ascribes notwithstanding to the indolent, voluptuous and sordid habits which uniformly mark the subjects of a despotic government, the notorious deficiency, which characterized his age, in all the loftier and sublimer kinds of eloquence. The fact was, men no longer felt the noble enthusiasm,—the stirring excitement, which once fired their souls: αγευστοι καλλιστου και γονιμωτατου λογων παθους (ΤΗΝ ΕΛΕΥΘΕΡΙΑΝ λεγω). Very nearly the same sentiments are put by the author of the Dialogue on the causes of the decay of Eloquence (c. 40 and 41.) into the mouth of Maternus, who maintains that a great and distinguished eloquence is the nursling of licentiousness, and cannot exist in any well-constituted form of government. The excitements of popular applause, which, under the old Republic, were sufficient to enflame the most frigid orators, were wholly wanting under the quiet despotism of the lower

Suppose two children newly born. Their future talents and character, will, no doubt, be in a great measure the result of their education; but not entirely so. The child, which receives most pleasure from its perceptions, will be most curious and interested in examining the structure and learning the properties of the different objects from which they proceed, and associate the strongest feelings of delight with the kindness of its nurse and parents. Hence its intellect, in the natural course of things, will be most exercised, its domestic and social affections warmest, and its moral perceptions most vivid. The infant, on the other hand, which is less susceptible of pleasure and pain, will be comparatively dull and uninterested in the scenes and occupations of opening life; its sensations of delight being fewer and less powerful, its intellectual faculties will be less developed, its affections and its moral associations less vivid and efficacious. EDUCA-

Empire; and into this difference of circumstances the speaker resolves the whole question of the decline of oratory. His concluding words are remarkable: "Credite, optimi, et in quantum opus est, disertissimi viri, si aut vos prioribus seculis, aut isti, quos miramur, his nati essent, ac Deus aliquis vitas vestras, vestra tempora, repente mutasset, nec vobis summa illa laus et gloria in eloquentia, neque illis modus et temperamentum, defuisset. Nunc, quoniam nemo eodem tempore adsequi potest magnam famam et magnam quietem, bono seculi sui quisque, citra obtrectationem alterius, utatur."—*De causis corrupt. Eloquent.* c. 41.

TION may do much to render its subjects moral, intelligent and well informed; but, after all its efforts, there is a warmth and readiness of feeling—a glow of fancy—an energy of soul—which no art can bestow; and which, whatever shape the subsequent character may assume,—to whatever pursuits the mind may be directed—will remain unchanged, and indicate the child of Genius. NATURE supplies the material; the hand of education and circumstance may chisel it into any form, but cannot alter the material itself. The habits of the mind are the result of education; nor does there seem much difficulty, when we consider the various influence of circumstances, in accounting for the *varieties* of character. But there is still a difference in the original power—the innate capacity—of the mind, which circumstances are inadequate to explain, and the probable occasion of which has been suggested in the foregoing supposition.

We have already mentioned quickness, variety and extensiveness of association, as characteristic of Genius; qualities which are the foundation of fancy and invention. It may be shewn then, I conceive, how these several functions, or rather habits, of the mind are dependent on the strength of those

primary impressions on the senses, which are the origin of our associations, and which are accompanied by a lively sense of pleasure and pain. Where this pleasurable or painful sensation is most acute, the impression sinks deepest and leaves the most vivid traces on the memory. Every thing associated with that primary impression, every thing which it suggests, or by which it is suggested, excites an emotion strong in proportion. All impressions being strongly marked are distinctly recollected, and occur to the mind, in various classes of association, as strikingly pleasurable or painful. They do not float dimly and cloudily through the brain; which would be the case, if no emotion were connected with them: but, if I may use an image to express my meaning, they are like so many luminous points, between which, as they pass before the mind, from the distinctness with which they are beheld, and the strong interest they excite, associations are quickly, variously and extensively formed.

Let us suppose an individual, a painter or sculptor if you please, to have acquired, from whatever cause, an exquisite sense of beauty in the human form. The features, limbs and attitudes, which have struck him in the course of his observations as most perfect and

graceful, and affected him with the liveliest emotions of delight—are treasured up in his memory and bound together in an indissoluble chain of association. When he meditates some new creation of the pencil or the chisel—these scattered elements of ideal beauty, as if summoned by the wand of an enchanter, rapidly assemble at the call of the predominant association, and bring from every province of nature and art the choicest treasures of grace and loveliness.(*j*) The stronger the impression, which they originally produced—the more readily will they now offer themselves to the selection of the fancy; the more glowing will be the enthusiasm which they inspire; the brighter, fresher and more original, will be the forms of beauty in which they combine and develop themselves. This process of the mind is exquisitely unfolded

(*j*) ——————From the womb of earth,
From ocean's bed they come: the eternal heavens
Disclose their splendours, and the dark abyss
Pours forth her births unknown. With fixed gaze
He marks the rising phantoms. Now compares
Their different forms; now blends them, now divides,
Enlarges, and extenuates by turns;
Opposes, ranges in fantastic bands,
And infinitely varies.

Pleasures of Imagination.—Book III. 387.—395.

by one of the greatest of our modern poets in describing the Apollo Belvidere.

> In his delicate form———————
> ———————————are expressed
> All that ideal beauty ever blessed
> The mind with, in its most unearthly mood;
> When each conception was a heavenly guest—
> A ray of immortality—and stood,
> Starlike, around, until they gathered to a God.(*k*)

Whatever an artist feels strongly becomes virtually his own. The wider and more various his associations with the productions of other men, as well as with the works of nature, the better. Acute sensibility to the sublime and beautiful, which depends, I conceive, under the guiding hand of education, on a strong original susceptibility of temperament, is indeed the *principle* of Genius; but without abundance of materials to work upon, it must soon exhaust its inventions and discover barrenness and penury. He, therefore, who has the widest range of associations, and the most extensive acquaintance with the master-productions of Genius in every age—if he deeply feels the impressions, which they leave, and makes them his own—is most likely to be distinguished by richness and

(*k*) Childe Harold's Pilgrimage, Canto IV. 162.

originality of invention. The greatest poets have been scholars; and where the imperfection of their education has denied them access to the stores of erudition, they have supplied the deficiency by acute and extensive observation on men.(*l*) Sir Joshua Reynolds has well illustrated my meaning in his comparison of the works of Luca Giordano and La Fage with those of Raffaelle.(*m*) The two former artists were distinguished for their readiness of invention; in other words, they drew on their own resources: and yet "in all their works" says our author, "which are (as might be expected) very numerous, we may look in vain for any thing

(*l*) It would, I think, be difficult to adduce a single example of a poet of distinguished excellence, who did not possess, for the times in which he lived, a very considerable portion of learning. I say nothing of the Greeks, because, as they were the Fathers of art, learning, properly so called, could hardly have any existence among them. But of the Romans, it may suffice barely to mention the names of Lucretius, Catullus, Ovid, Virgil, Horace and Propertius; and of the moderns, Dante, Chaucer, Ariosto, Tasso, Spencer, Jonson, Fletcher, Milton, Dryden, Pope, Collins, Gray.—It may be thought sufficient to array the single name of Shakspeare against this long list of authorities for my assertion. Dr. Farmer, in his Essay on the Learning of Shakspeare, has indeed very decisively disproved the claim of our great dramatist to *scholarship*; but of learning, in a looser sense of the word, it can hardly be affirmed that he was destitute, in an age, abounding with translations from every language, and opening, in the vernacular tongue, sources of information on all subjects, of which there is proof, in his works, that our Poet made abundant use.

(*m*) Works, vol. 2d, p. 88—91.

that can be said to be original and striking." No man, on the other hand, ever possessed a greater power of invention and stood less in need of foreign assistance than Raffaelle; yet the works of this great painter evince his familiarity with the productions of preceding artists, and instances might be adduced of his not disdaining to borrow. By this extensive and exact acquaintance with the works of art, he greatly enriched the circle of his associations; and he made the beautiful creations of other minds his own, by intensely feeling their loveliness, and imbibing it, as it were, into the very essence of his Genius.

It may be regarded as something like a confirmation of the foregoing views, that the history of most men of Genius shews them to have been imbued with a very high degree of sensibility to all great and sublime truths—to all generous and exalted moral sentiments—and usually also to the beauty and grandeur of the natural world. Education may do much to repress and pervert the natural sensibility; habits of recluse and abstract speculation may contract the heart; the passions, interests and prejudices of the world may have nearly dried up the native fountain of inspiration:—but they must still retain a sympathy with the natural affections of the hu-

man soul, they must still be capable of interest and delight in what is great and beautiful and wonderful, they must still be capable of pursuing it with ardour and enthusiasm;—or they do not seem to possess a single particle of that etherial spirit, which we call Genius. What are the passages in their works, from which we infer their Genius? Are they not those, in which some appeal is made to the generous and benevolent sympathies of the uncorrupted heart?—those, which discover an acquaintance with the secret springs of human happiness and misery?—which unfold original and striking views of the œconomy of providence and the destinies of the human race?—which throw a new light upon the world in which we are placed, and seem to bring us a step nearer to the immediate agency of God?—those passages in fine, which search the depths of the heart, glowing with the love of our species, and eloquently asserting the eternal interests of truth, justice and freedom? Every one will recollect passages such as these, in the works of his favourite authors. It matters not to what age or country or party they belong; where their Genius produces its finest efforts, it appeals to those universal sympathies—those inextinguishable charities of the human heart, which must be

felt before they can be excited, and which are founded on our original capacity of pleasure and pain. There is nothing artificial and elaborate in the productions of real Geniuses; their writings, like their characters, usually combine grandeur of conception and oftiness of purpose, with a playful gentleness of manner and a dignified simplicity of expression. On minor points, men thus highly gifted may differ from each other; but where the great questions of human weal and woe are concerned—where the generous and exalted emotions of the heart are interested—there, if we may judge by their writings, they cordially unite in one common sympathy—in one universal sentiment. On occasions like these, they seem borne by the native buoyancy of their etherial spirits above the vulgar prejudices and sordid passions of the crowd into a purer element of noble and virtuous enthusiasm.

> Ignea convexi vis et sine pondere cœli
> Emicuit, summâque locum sibi legit in arce. (n)

The hypothesis, which we have now stated, seems easily to account for that original difference of mental constitution, which subsists amongst men, and which no education

(n) Ovid. Metam. I. 26.

can wholly overcome; and, at the same time, leaves enough to the influence of circumstances, to explain that connection, which may in all cases be traced between an individual's education and his character. But it may be objected, that, on this hypothesis, as the only original difference, which we recognize in the minds of men, is a greater or less degree of natural sensibility to pleasure and pain, in those primary impressions, which are received through the senses; there must be a regular gradation of temperament in the human constitution, from the highest to the lowest degree of natural susceptibility; and thus, no distinct boundary can be marked out which separates from the intellectual patrimony assigned to the multitude—the consecrated enclosure of Genius.(o) And if this be the case,—where then the distinctive characteristics of Genius?—where the originality, freshness and vigour of mind, which were represented as its peculiar prerogative? In reply to this objection, of of which I feel the force, it must be observed, that two causes co-operate to the production

(o) Ενθ' ουτε ποιμην αξιοι φιρβειν βοτα,
ουτ' ηλθε πω σιδηρος, αλλ' ακηρατον
μελισσα λειμων' ηρινον διερχεται,
αιδως δε ποταμιαισι κηπευει δροσοις.

Euripid. Hippol. 74-7.

of character—the original constitution of the mind, and the influence of circumstances. The *foundation* of Genius we believe to consist, as already stated, in a more-than ordinary susceptibility of temperament, which renders its possessor exquisitely sensible to pleasure and pain; but its *development*—or, in other words, the particular direction which it takes—is occasioned by the concentration of its sensibilities on some particular object—a concentration, which may be accidentally produced, but which yet could happen only in a mind of uncommon ardour and susceptibility. It is in this enthusiastic devotion to some one pursuit—this determination of the energies into some one channel—this permanent ascendancy of some reigning association of ideas—that we are frequently able to discover the presence of Genius—and to distinguish it from the workings of those inferior minds, which seem incapable of any strong attachment, and, with the most insipid pliability, take the impression of the circumstances to which they are successively exposed. In the lives of many eminent Geniuses—we may trace their tone of thinking—their style of writing—their manner in the practice of any art—to some circumstance occurring in early life, which took a power-

ful hold of the fancy by exciting some very pleasurable or painful emotion, and which became, in consequence, the basis of some association reigning for ever afterwards in the mind. This predominant association gives its peculiar character to Genius; it is a sort of standard, to which all the ideas are referred; a fixed point, to which they have have all a marked and definite relation; the central image of the mind, which is reflected in various shapes and hues from the surrounding mirror of nature. To a dull and insensible mind few events possess sufficient interest, to leave behind them a strong and lasting influence on the character. Their traces are effaced by the impressions of succeeding events; and the mind takes its ultimate form and character from the plastic hand of an artificial education. It adopts implicitly the feelings and associations of others; it thinks through the medium of their reasonings; it looks at nature and society under the particular aspect in which the world has chosen to present them. But, on the other hand, when the soul is endued by nature with an ardent and enthusiastic temperament; and its energies and its sensibilities have been all determined by some powerful association of pleasure and pain into a particular direction;—

those qualities of mind are produced, vividness of conception, eagerness of purpose, and originality of sentiment, which we have already enumerated as characteristic of Genius. The *power* of Genius will depend, I conceive, upon the degree of constitutional susceptibility; its *tone* and its *character* will be decided by the accidental circumstances, which call it into exercise, and which are, in fact, the occasion of its development. It has almost passed into a maxim, that whatever a person likes, he does well; nor can it reasonably be doubted, that many of those characteristic qualities of Genius, which seem to be the gift of immediate inspiration, are really caused by the deep and enthusiastic interest, with which it pursues its favourite object. Upon what occasions are our conceptions so bright, distinct and glowing, as when we contemplate some approaching event with eager delight or shuddering apprehension? When do we resolve and act with such decision and enthusiasm, as when our motives rest on some great question of happiness or misery, which arbsorbs our whole attention? When is our reason so discursive—so prompt to marshal and review its various trains of ideas—so quick to discover the most delicate relations between

them—as when the thoughts are thrown, by some powerful association of pleasure or pain, into a particular channel, and the attention is perpetually brooding on one exclusive theme? Let us suppose this strong excitement, which occasionally gives such preternatural acuteness to the faculties of ordinary men, to be continually present to the mind; and we have a key, if I mistake not, to some of the mysterious operations of Genius.

When some predominant association has taken possession of the mind, it turns the thoughts into one direction, awakens the attention, and gives an air of originality to the views and feelings. It is this central association, if I may so call it, ruling all the thoughts and infusing a peculiar tinge into all the sentiments, which stamps its character upon Genius; it is this, which delivers its possessor from the trammels of an artificial education;—which lifts him to an eminence above the ordinary level of society;—which changes to his view all the common-place appearances of nature and society, and enables him to take his own *coup d' œil* of their wonders. It is from this same enthusiasm and susceptibility of temperament—this eager devotion of his mind to some darling pursuit—that he discovers rela-

tions and traces analogies between the moral and the natural world and the various objects of each, which wholly escape the common eye. Aristotle(*p*)represents this quickness to discern analogies amongst the different objects of thought and perception, as a quality which no education can give, and the surest indication of Genius; but it could not, as I conceive, exist, or at least would not be exerted, unless there were some one idea, about which the mind felt a more than usual interest and which formed the centre of its associations. Some strong association of delight, grandeur, beauty, wonder and utility with this favourite conception induces us to view it on all sides, and examine its relation with our other ideas; and, kindling our enthusiasm, gives to the expression of our thoughts an air of freshness and originality.

One of the chief causes of great intellectual power lies in the faculty of close attention.

(*p*) Το δε μεγιστον, το μεταφορικον ειναι· μονον γαρ τουτο, ουτε παρ' αλλου εστι λαβειν, ευφυιας τε σημειον εστι· το γαρ ευ μεταφερειν, το το ομοιον θεωρειν εστι. De Poeticâ. XXXVII. The sense is excellently conveyed in the paraphrase of M. Batteux: "C'est la seule chose, qu' on ne puisse emprunter d' ailleurs. C'est la production du Genie, le coup d' œil d' un esprit, *qui voit les rapports.*"

To his possesing this power in a very high degree, Sir Isaac Newton ascribed his sole pre-eminence above other men. That faculty of long and continuous attention, what the French call *attention suivie*, which is the foundation of proficiency in the sciences, is rather the result of education and habit than the gift of nature: but attention, as a little enquiry may satisfy us, is, in the first instance, most readily bestowed, where the most lively interest is awakened; and interest will always be most intense, where the associations of pleasure and pain are the strongest. The habit of attention, I admit, must be acquired; but we must excite it in the infant mind at first, by presenting some object, which awakens a lively sensation of delight. The *capacity* of attention, whether the *habit* has been promoted or neglected by education, will, I apprehend, in all cases, be proportioned to the liveliness of the original susceptibility of pleasure and pain.

Perhaps it may be thought, that, even if this theory be deemed to furnish a plausible account of the nature of Genius, as displayed in the inventions of poetry, eloquence and the arts; it is totally inadequate to explain that development of it, which is seen in the cultivation of the exact sciences and philosophy.

But we must here take fully into consideration the wonderful effect of circumstances, in giving a particular bias to that enthusiastic temperament, which we conceive to be the basis of all Genius. If there be a strong original sensibility to pleasure and pain, it will impart its strength and vivacity to all the subsequent associations, even though they should relate to subjects, the farthest removed from the ordinary sympathies of human nature, the properties of lines and quantities, or the proportions of forces and gravities. Let there be a deep interest felt for any subject—let the attention be turned to it with concentrated force—let a strong association of its importance and excellence be permanently established; and the mind will discover a quickness and perspicacity and a fertility of invention, which have all the appearance of intuition; and which minds of less ardour, whose attention is distracted by a multiplicity of vulgar objects, never can exhibit. A proficiency in science depends, in a great degree, on the habits early formed; and it is rare to find an individual, distinguished at once by his acquisitions and discoveries in the sciences, and his skill in the polite arts. Not because the two kinds of Genius are not fundamentally the same; (for,

according to our theory, they both arise from an original susceptibility of temperament) but because they are developed by habits of a very different kind; and, when these habits are once formed, it is difficult to shake them off, and assume others which are almost incompatible with them. It is a constitutional warmth and sensibility of mind, which fits us to bestow a profound attention, and to feel a lively interest; in this lies the foundation of Genius: circumstances will decide whether its enthusiasm be directed to philosophy, science, literature, or the arts. The determinaton may be given at an age, to which the record of the biographer does not ascend; and the associations of interest and delight, thus early awakened, may be so vivid—and the habits, formed in consequence, may be so firmly established and have become so prompt and active, as almost to unfit the mind for any pursuit, but that on which its energies and sensibilities have been concentrated, and to induce the belief that it was born with an original aptitude for it.(q)

(q) The effects of close and continued attention to one subject almost exceed belief. *Nil mortalibus arduum est.* In the operations of manual skill, as evinced by jugglers and some kinds of handicraftsmen, they emulate the marvellous results of magic. From a long train of observations on the appearances of the elements and the minute process

To the more direct reasonings, by which we have endeavoured to support the foregoing theory of Genius, we may add the two following general considerations. If the foundation of Genius lie in a constitutional susceptibility of temperament, it is obvious that it must, in some way or other, depend on the bodily organization; and consequently, whatever circumstances modify the physical constitution of man, may be supposed to have a proportional

of nature, even rude and uncultivated minds acquire a sagacity and foresight, which resemble inspiration:

Till old experience do attain
To something like prophetic strain.

When such are the effects of habit and attention, in cases where Genius is out of the question; what may not be expected from a mind of superiour order, all whose associations, from its constitutional susceptibility, are peculiarly bright and strong, and whose habits, from an early determination of the attention to some particular pursuit, have attained almost the quickness and promptitude of instinct?—Some singular cases are on record of a partial development of intellect. Of these one of the most remarkable, which has occurred of late years, is that of Richard Roberts Jones; an account of whose extraordinary talent for the acquisition of languages, conjoined with an almost idiotic deficiency in the ordinary operations of intellect, is given in a little memoir, which, I believe, I am correct in ascribing to Mr. Roscoe. The views above stated coincide with the explanation offered by Mr. R. of this singular phœnomenon; which, he conceives, has arisen from an *exclusive* direction of the attention to mere philology. Upon similar principles, we may perhaps account for those occasional instances of early and almost miraculous skill in calculation, accompanied by a corresponding deficiency of judgment and observation in other respects. Whatever attention the individual was capable of bestowing, was turned into one channel and concentrated on a single object. The reader will at once recur to the well-known case of Jedediah Buxton, and remember the account of his

effect onthe development of Genius Of these circumstances climate is one of the most important. In the delicious countries of the South of Europe, in Italy and in Greece, the frame of man, endued with an exquisite susceptibility and an uncommon delicacy of sense, supplies the imagination and the feelings with continual excitement. These regions have accordingly been the cradle of the fine arts and the cherished haunts of the muses.

remarkable behaviour, when taken to the theatre. Some of the most remarkable examples of a precocious development of Genius occur in the annals of Music. For early proficiency in this art, nature must have provided an exquisite delicacy and sensibility in the organ of hearing; it is this which constitutes the determining circumstance of the Genius, and draws the whole power of the nascent intellect to the office of noting and recording and associating the most latent and delicate relations of harmony. The auditory nerves of Mozart, as we are informed by his biographer, (Life of Mozart p. 345) were so exquititely susceptible, that, in early childhood, the sound of a trumpet nearly threw him into convulsions, and every false note was a perfect torture to him. From this organization of the ear result those strong associations of delight with the art of music, which fix the taste, and mark out the sphere in which the imagination and sensibility are to operate. The passion may sometimes, as seems to have been the case with Handel, be excited and confirmed by unseasonable opposition; sometimes, as in the instances of Haydn and Mozart, encouraged by early intercourse with musical men. But that exclusive devotion of the attention, which seems indispensible to attaining the highest excellence of musical composition, is purchased mostly by a corresponding imperfection in the development of the reasoning powers. I believe no instances are to be met with of distinguished musical genius, associated with great general talent. In many cases, it is accompanied by a deficiency of intellect. Mozart was little better than an ideot, except at the harpsichord.

The gay and laughing literature of the South is strikingly contrasted with the gloomy and awful legends, which nourished the wild songs of our Scandinavian forefathers in the forests of the North. There is indeed an occasional grandeur and sublimity in these Runic strains, suited to the stern, heroic, character—the robust and firm-knit frame—of the people, by whom they were sung: yet it may be doubted, whether of themselves they would ever have led to the formation of a literature, distinguished by the variety and brilliancy of its inventions, or by any of those qualities which we are accustomed to consider as peculiarly characteristic of Genius. What, for example, did the Anglo-Saxon Muse produce, before her alliance with the literature of France? Certain it is, that to the influence of the rich and glowing fictions of the South, and a devoted admiration of the splendid models of Greek and Roman Genius, we owe the stimulus, which first awakened the dormant energies of our national spirit, and prompted all that is most impassioned in our eloquence, most enchanting in our poetry, and most brilliant in our works of art. So that in those countries, where the human frame seems endowed with the most delicate and susceptible organization, we

find the sensibilities most acute and the imagination most exalted; it is in these warm and sunny climes, that

> Bright-eyed Fancy, hovering o'er,
> Scatters from her pictured urn,
> Thoughts that breathe, and words that burn.(r)

There is another general consideration, which tends to the same effect as the preceding. If Genius depend on some circumstance connected with the bodily organization, we should expect to find it occasionally, to a certain extent, hereditary; an expectation justified, as we shall discover upon enquiry, by the matter of fact. It is a colloquial remark, not less true than frequent, that talent *runs* in certain families. Nor can this be set down to the benefit of example or superior instruction; we often find the *constitutional* complexion of mind transmitted from father to son. One reason, why we are less aware of the fact, may be, that in the case of very distinguished individuals, the splendour of their name quite eclipses the merits of their descendants, though they may retain a considerable portion of their genius. The world has generally agreed to stigmatize Marcus Cicero as a blockhead, because

(r) Gray's Progress of Poesy, III. 3.

he had the misfortune to be the son of the most illustrious genius of ancient Rome; yet Middleton has shewn that, however inferior he might be to his father in the amiable and temperate virtues, he was by no means deficient either in talents or literary taste, and enjoyed the friendship of Brutus, and the respect of Augustus.(*s*) The lives too of men of Genius are often so irregular and eccentric, and their pecuniary means so narrow and precarious, that their posterity enjoy perhaps fewer advantages of education, and of introduction into life, than the offspring of inferior men: and hence they sink in the scale of society, and pass their days in insignificance and poverty.

According to the theory then, which we have attempted to establish, men of Genius are distinguished from other men, first, by receiving from the hand of nature a more than ordinary share of constitutional susceptibility; and secondly, by having their sensibilities and their attention directed, at an early period, by some accidental, but lasting, association, into a particular channel and concentrated upon a certain class of objects.(*t*)

(*s*) Middleton's Life of Cicero, Vol. III. p. 401, et seq.

(*t*) We believe there are very few, if any, examples of *universal*

Both of these circumstances enter essentially into our idea of Genius, and seem necessary to endow it with those qualities of vivid conception, of glowing enthusiasm, and of original sentiment, which we specified, in the commencement of the Essay, as its distinguishing characteristics. We do not, for example, suppose that a man is born with a specific Genius for painting, oratory, or poetry; that he is peculiarly fitted, by his original constitution, for becoming an ingenious mechanic, a skilful logician, a sagacious philosopher, a musician, an actor, a

geniuses. There have been men of universal *acquirements* in every walk of literature and science; but to create, and invent, and strike out new views, in any *one* department, seems to require the concentrated energies and undivided attention of the whole mind. Of the ancients—when we consider the number and variety of his writings, perhaps Cicero may be alleged as an exception to the foregoing remark. Yet, as a poet, he is proverbially unfortunate; and, after a fair estimate of his works, his most enthusiastic admirers must admit, that eloquence was his *fort*—the channel, into which the stream of his genius had been directed; and that the many beautiful and glowing passages, with which his philosophical treatises abound, cannot redeem them from the heavy charge of perplexed arrangement, of imperfect definition, of loose and inconclusive reasoning. Among the moderns—where shall we look for examples of universal Genius? In the characters of the admirable Crichton and of Sir Philip Sidney, there is much of the ostentation and pedantic display, peculiar to their age, but none of the features of real Genius. Of the distinguished individuals of later ages, Grotius and Milton, Sir W. Jones and Voltaire, bid as fair, as any that occur to me, for a claim to the honours of universal Genius. Yet the decided bent of the mind of our great epic poet was to moral and religious truth; and his multifarious erudition supplied him with the materials of illustrating

navigator, statesman, or general: but that, inheriting from nature an enthusiastic ardour and exquisite sensibility of soul, arising, as we conceive, from the original susceptibility of his temperament, he is directed by accident to the pursuit of some particular object in literature, science, art, or active life; and that, in consequence of this determination of his attention to some single department, his faculties acquire a force and a promptitude, and a fertility of invention in that particular sphere, which are easily mistaken for the results of a constitutional apti-

and adorning his favourite subject. We have evidence that his immortal poem had been, for many years, before he sat down to execute it, the idol of his thoughts, and the theme of his fervent meditations. Grotius and Jones (names which cannot be pronounced without the profoundest reverence by every lover of virtue and freedom) were rather scholars than inventors; they extracted truth and wisdom from mines, which had already been worked by others, rather than opened a vein of their own; nor am I aware, that they have added any discoveries to the stores of philosophy, or, in any wise, enlarged the boundaries of science. Had the energies of their mighty minds been more concentrated, it is not improbable their writings might have discovered more of those original and striking views, which are peculiarly characteristic of Genius. Voltaire was unquestionably a genius; yet he himself thought he had no title to the rank of an universal genius. He was of opinion, that his fame with posterity would rest on his dramatic works.—Some perhaps would be disposed to add the name of Priestley to this list; yet, I apprehend, he can claim originality and invention only in the department of physical science. In fine, the observation of Cornelius Nepos (*Fragm. de laude Ciceronis*) is eminently just and philosophical: "locuples ac divina natura, quo majorem sui pareret admirationem, ponderationeque suæ essent beneficia, neque uni omnia dare, nec rursus cuiquam omnia voluit negare."

tude. Early associates, the repression or encouragement of the nascent propensity by friends, the state of the health, or of the bodily frame, will affect the development and modify the character of Genius; turning it to action or contemplation, inviting it to the pursuit of truth, or the cultivation of beauty, inspiring it with a love for the sweet and pathetic, or the awful and sublime. Had Lord Bacon and his great dramatic contemporary exchanged their education and early circumstances—upon the present theory, we should think it highly credible, that Shakspeare would have been a distinguished philosopher, and the philosopher an illustrious poet. It is however the strong predilection of the mind for some one object—the effect of an accidental influence upon a constitution originally susceptible—which gives to Genius its power and its character. In cases, where this determination has never been produced—there may be great general talent—there may be the *materiel* of Genius, but its effects are not developed. Our theory therefore coincides with the original and proper signification of the word Genius, in representing it to consist in the strong bias of the mind for a particular pursuit—as if under the constant influence of a *tutelary spirit*. It agrees too, in

the main, with the celebrated definition of Genius by Dr. Samuel Johnson; "that it is nothing more than strong general powers, accidentally determined to a particular direction." Nor are our views inconsistent, on the whole, with those, which have been so eloquently unfolded by Sir Joshua Reynolds in his discourse on Genius. His definition of it, as applied to the practice of the art of Painting, is that it "consists in the power of expressing an object, whatever it may be, *as a whole;* so that the general effect and power of the whole may take possession of the mind." To be able to do this, the artist must have a quick perception of the expressive features of nature; and accustom himself, by comprehensively associating them in his mind, to survey nature with a painter's eye.*(u)*

(u) It has been objected to the foregoing theory, that, by making Genius to consist in susceptibility of temperament, we do not sufficiently distinguish it from Taste, which implies an exquisite sensibility to the beauties of nature and art. The following considerations, which are quite consistent with our views, sufficiently point out the distinction between these two faculties. Genius is active, and delights in the expression of its own enthusiastic feelings and original views; Taste is a passive quality, which yields itself quietly to the influences of other minds and terminates in enjoyment: Genius is the gift of nature; Taste, the result of education: we meet with Genius in all states of society and all ranks of life; Taste characterizes periods of high cultivation, and is rarely found but in the polished and well-educated classes of the community. To explain this, it should be recollected, that although

The circumstance, which determines the bent of the Genius by inspiring it with the predominant association, often occurs at a period of life too early for record. To the influence and instructions of the mother in the very dawn of intellect, more perhaps than to any other general circumstance, the mind is indebted for its first impulse and the elements of its subsequent character. Nor do we find any fact more frequently mentioned in the lives of distinguished men, than that of the stimulus applied to their awakening faculties by the foresight of maternal affection. So

we represent susceptibility of temperament to be the foundation of Genius, yet we have all along supposed, that its effects—the characteristic qualities, which we have formerly enumerated, will not be developed, unless this constitutional ardour of soul be determined to some particular pursuit; and that it is this concentration of its faculties, which gives to the mind its originality and its creative force. Where the natural sensibility is exceedingly strong, it is most likely that some such determination will, at some time or other, be produced. But a far inferior degree of original sensibility is sufficient to lay the foundation of Taste; a quality, which can be matured by a liberal education alone—but which strengthens by exercise, and which the incessant renewal of pleasurable associations with the works of nature and art renders at length exquisitely alive to beauty, and susceptible of emotion. In confirmation of these views, we may observe that Taste seems to be as *universal*, as Genius is *restricted*, in its operations. While the painter and the poet are unable to excel, except by confining their attention to their single department; the man of Taste addresses himself with equal delight to all the various creations of the imagination; nor is there a beauty in the whole range of nature or art,

> ——"but whence his bosom can partake
> Fresh pleasure unreproved."

many instances occur, in which we can clearly trace the peculiar bias of the Genius to some affecting event of early life, which left a lasting impression on the mind and turned all the thoughts and studies into one direction, that we may perhaps, without any great presumption, suppose that such circumstances are always the real occasion of the development of Genius, though they may often escape our notice. In an Essay, which is, I fear, already too long, it can hardly be expected, we should quote many examples. I shall only specify one or two, that are rather remarkable. Cowley's taste for poetry, as we learn from himself, was first excited by reading Spenser's Fairy Queen, which lay in the window of his mother's apartment: a circumstance, which has drawn from his biographer Johnson the celebrated definition of Genius quoted above. We are informed too, that this poet's mother was extremely anxious to procure him a literary education, and would doubtless encourage, by every means in her power, his growing taste for letters. The circumstances, which gave so fortunate a direction to the mighty genius of our Shakspeare, were his running away from home and attaching himself, from the want of a bare subsistence, to the players. Had not

this necessity occurred, he might still have been distinguished, but we should probably have had none of his dramas. Chatterton's history is very remarkable. He could not be induced to learn his letters, till his attention had been caught by the illuminated capitals of a French musical MS.; and his mother afterwards taught him to read from an old black-letter Bible. In this way, his taste for antiquities and old English learning was first awakened; and it was afterwards strengthened by deciphering the curious old parchments, which his father had purloined from the muniment room of the church of St. Mary Redcliffe, Bristol, and which he used for covering books in his school. The propensities of the youth, thus excited, found additional nutriment in the gratification, which the architectural remains of his native place furnished to a romantic and antiquarian mind. We may estimate the effect of these early associations on his Genius by considering the acknowledged fact, that his poems in the old English dialect, which he attempted to pass off as the productions of Rowley, are decidedly superior, in all the qualities of genuine poetry, to those which he wrote in modern English.(*x*) The enthusiastic fondness of

(*x*) How strongly and how permanently the most trifling circum-

Thomas Warton, the historian of English poetry, for Gothic architecture and for the wild, romantic associations, with which it is connected, has been ascribed with great probability by his brother to a very strong impression of delight made upon him at an early age, by seeing Windsor Castle. Mr. D'Israeli, in his illustrations of the literary

stance may impress the mind of youthful Genius, and what encreased vividness it may add to the associations of delight with its favourite pursuit—we may learn from the following curious anecdote in the life of Haydn:—*Reuter, Maitre de Chapelle* of St. Stephen's, Vienna, who who was in treaty with the relatives of Haydn, to receive him as one of the choristers of that Cathedral, had been teaching the little musician how to shake. The child immediately made a good shake. *Reuter*, enchanted with the success of his scholar, took a plate of fine cherries, which had been brought for his own refreshment, and emptied them all into the child's pocket. His delight may be readily conceived. "Haydn" says his biographer "has often mentioned this anecdote to me, and he added, laughing, that, whenever he happened to shake, he still thought he saw these beautiful cherries." This reference to musical Genius calls to mind some circumstances in the early history of Mozart, strongly corroborative of the principles, which we have attempted to lay down on this interesting subject. "Before he had acquired a decided taste for music, he was so fond of all the amusements of his age, which were in any way calculated to interest him, that he sacrificed even his meals to them."—"While he was learning arithmetic, the tables, the chairs, and even the walls, were covered with figures which he had chalked upon them. The *vivacity* of his mind led him to attach himself to every new object that was presented to him. Music, however, soon became again the favourite object of his pursuit." He was distinguished also by the warmth of his affection. "He would say ten times in a day to those about him, *Do you love me well?* and whenever in jest they said *No*, the tears would roll down his cheeks."

Lives of Haydn and Mozart, from the French of L. A. C. Bombet. pp. 26 and 338.

character, drawn from the history of men of Genius, has adduced one or two examples, which, he thinks, prove an original determination of the mind to some particular pursuit, and are irreconcileable with the idea of referring the development of Genius to the influence of casual excitement.(y) The first instance is that of Ferguson, the natural philosopher, who learned to read, by listening to his father teaching his brother. A similar story is related of Madame Dacier, the learned daughter of Tannegui le Fevre. We do not believe such cases wholly incapable of explanation. All instructors of youth very well know, that the attention, in quick and susceptible minds, is often most freely bestowed, where it is not constrained. Within my own experience, I knew a boy, who committed accurately to memory the whole of an elementary book, by merely hearing his school-fellows repeat their tasks. The caresses and admiration, which this voluntary triumph over the difficulties of learning usually attracts from parents and friends, add fresh excitement to the awakened propensity, and connect a lasting association of interest and delight with those first efforts of the in-

(y) The Literary Character illustrated, &c. pp. 45-7.

tellect which are usually remembered with disgust. An appetite for knowledge being once communicated to the mind, it will eagerly seize upon all the mental food which comes in its way, and make the most of what is offered to it. Another case, quoted by the same writer, is that of the Abbé la Caille, one of the first astronomers of his age. He was the son of a parish clerk, who sent him every evening to ring the church bell. During this lonely occupation, the boy's chief pleasure was in watching the stars from the steeple; an employment in which he took such delight, that he often staid beyond the hour appointed by his father, and was severely punished when he returned home. Mr. D'Israeli finds here an example of instinctive Genius, operating in spite of obstacles. On the contrary, it seems to me that no circumstances could have been more likely to kindle, in a youth of sensibility, a fondness for watching the motions and appearances of the heavenly bodies than those in which the young La Caille was placed. They were, in fact, no other than those, to which historians have perpetually ascribed the early proficiency of the Chaldean priests in astronomy; retirement, silence, and the enjoyment of a clear, unbroken horizon. These associations

of delight with the phenomena of the skies were strengthened, in the mind of the young philosopher, by contrasting the quiet luxury of his evening meditations with the brutal treatment he experienced at home. An anecdote recorded in the early history of Clairon, the great tragic actress, appears to Mr. D'Israeli to contain decisive evidence, that the development of Genius is not accidental. I am again under the necessity of dissenting from him. That remarkable woman inherited from nature, I admit, an enthusiasm and sensibility of soul, which fitted her to become distinguished in some line or other; but I cannot suppose that any constitutional bias destined her, from her birth, to the particular department in which she afterwards excelled. Let the question be decided by an appeal to facts. Clairon was the daughter of an illiterate and violent woman, who was incessantly driving her with threats and menaces to manual labour. Her quick and susceptible spirit strongly felt the miseries of such a situation, so ill-suited to the vivacity and playfulness of childhood. One day, when she had been locked up by her mother in a room, as a punishment, she climbed up to the window, to look about her. In the house oppostie, she observed a

celebrated actress, in the midst of her family, instructing her daughter in dancing. When the lesson was ended, she saw the child warmly applauded by the family circle, and fondly caressed by her mother. Clairon contrasted her own situation with that of the happy girl whose performances she had just witnessed. From that day forth, she delighted to repair to this chamber, and gratify herself with watching the theatrical studies of the family opposite. That association of pleasure with the motions, attitudes and declamation of the stage, which gave the impulse to her Genius, was now fixed; and it was strong from the force of contrast. Nor would I desire a more convincing example of the effect of accidental circumstances, in determining the particular sphere in which Genius is to operate.

In the early life of the late President of the Royal Academy, we meet with a circumstance, which pleads more strongly in favour of an original predilection for some particular art, than any with which I am elsewhere acquainted.(*z*) Benjamin West was born in a retired part of North America, among a settlement of Friends. At the age of seven years, when he had never seen an engraving or picture, he was one day left

(z) Galt's Life and Studies of Benjamin West, &c. p. 10.

by his mother to watch the cradle of an infant. The child smiled in its sleep; and young West, smitten with the beauty of the expression, seized a pen and endeavoured to delineate it upon paper. His attempt was eminently successful and warmly applauded; and from the time of this first unassisted essay, he continued passionately devoted to the art of design. Be it however remembered here, that if there be any thing in our nature, which deserves the name of instinct, it is the propensity to imitate; a propensity, which adheres to the human being under all circumstances and is perpetually urging him to try his hand, in the rude and simple essays of art. The unexpected success of West's first attempt at design, combined with the admiration and praises of his friends, created in his mind that strong association of delight and conscious pride with his art, which kindled an undying passion for it and prompted him to excel in it.

The only circumstance in the original constitution, which, from the birth, I can conceive to have any influence in determining the course of the Genius, must be an extraordinary perfection in some one of the senses. Thus a peculiar delicacy of hearing may be supposed to produce a musical composer; a fineness of sight or touch to make

a painter or a modeller. These natural gifts however, when considered in this light, must be classed with the external circumstances, which modify the development of Genius; they are a part of our physical nature, which may conduct, or even be indispensable, to technical excellence in the several departments of art: but creative power—that which can awaken sentiment, and astonish, melt, or delight—must be derived from mind—from that enthusiasm and sensibility of soul, which we have uniformly represented as the foundation of Genius.

Such are the observations, which we proposed to offer on the nature of Genius. We have attempted to detect its traces, and follow its windings, and pursue it to its source:

———sanctos ausus recludere fontes. (*a*)

Whether we have really ascended to the origin of this mysterious principle, which, like the Nile, has been supposed to descend immediately from heaven, because its fountain-head is enveloped in obscurity; or whether we have only discovered some inferior spring, pouring its tributary rill into the noble tide, which rolls majestically along from a source unknown, the wonder and the admiration of every beholder;—it is for those, who

(*a*) Virgil. Georg. II. 175.

have explored the same tracts and carried their investigation further, to determine. But we willingly indulge the belief, that every hypothesis, which is not flagrantly absurd, may have its use in exciting pleasant and instructive discussion, and in smoothing away a few of the roughnesses, which obstruct the avenues to truth. It is in this persuasion, that the foregoing views on the nature of Genius have been committed to paper, and are now submitted with deference to the consideration of the candid and judicious.

ON THE NATURE AND PROPERTIES OF INDIGO; WITH DIRECTIONS FOR THE VALUATION OF *Different Samples.*

BY JOHN DALTON, F. R. S. &c.

(Read November 14th, 1823.)

WE owe the first good approximation to the chemical analysis of the Indigo of commerce to Bergman. According to his experiments, the best samples of Indigo yielded, by analysis, the following principles:

47	pure Indigo
12	Gum
6	Resin
22	Earth
13	Oxide of Iron
100	

A subsequent analysis of Indigo made by Chevreuil, (Annal. de Chimie, tom. 68) gives 45 per cent. of pure indigo in the best Guatimala indigo, and the foreign matters much

the same as by Bergman, but differing considerably in the proportions. Indeed it is most probable that the foreign matters will be found to differ materially both in quantity and kind, from the various modes and circumstances of the manufacture as practised in different places, and perhaps from the various species of plants from which the indigo is extracted in different parts of the world.

It is to be understood that the part called *pure Indigo* is the sole colouring matter, and that which gives value to the article. The rest may be considered as dross, doing no good, and being probably harmless to the use of the drug as a dye, but scarcely so to the printer, who meets with obstructions enow in the exercise of his art, without introducing such as may easily be avoided.

When we consider, however, that indigo is produced by a species of fermentation from vegetable matter, analogous to the vinous and acetous fermentation of saccharine matter, it is not improbable that the fermentation in many cases may be incomplete. And as the foreign matter found in the indigo of commerce is chiefly vegetable, and composed of the same elements as pure indigo, it may by a fresh fermentation develope more of the

pure indigo than is found in it originally. This conjecture is countenanced by the practice of dyers, who, when the indigo is nearly spent, as the phrase is, put in other vegetable matter to the residue, and by certain processes obtain an addition to the quantity of colouring, which otherwise would not be acquired. In a similar way I conceive it is, that vinegar made from sugar, often contains a considerable portion of the latter, which has escaped the fermenting process.

There are two ways of obtaining pure indigo. The one is that commonly practised by dyers in their use of the article. On a small scale it may be effected as follows: Into a two-quart bottle put 50 grains of finely pounded indigo, three or four times as much sulphate of iron, and hydrate of lime same weight as the salt of iron. Then fill the bottle with water, leaving little more room than what the cork or stopper will occupy. Mix up the contents by repeated agitation, and then let the insoluble matters subside. A fine, transparent, greenish-yellow liquid will appear in a day or two, which must be drawn off carefully by a syphon. As soon as this liquid is agitated in the air it becomes opaque, and a precipitate is formed, which is pure indigo; but it cannot be col-

lected without some carbonate of lime in the first instance; it must therefore be submitted to water acidulated with muriatic acid, which dissolves the lime, and leaves the pure indigo to subside. Afterwards it may be collected on a filter and dried. The theory of this process is now well understood. Pure indigo, deprived of a certain portion of oxygen, is known to be soluble in lime water; the protoxide of iron, precipitated by the lime, deprives it of this oxygen, and hence the solution of the deoxidized indigo. Such however is the affinity of indigo in this state for oxygen, that it resumes it from atmospheric air the moment they are brought into contact.

Pure indigo thus obtained is called *precipitated* indigo: the solution may also be had from a blue dyer's vat, by plunging an empty phial into the liquid a few inches below the surface.

The other way of obtaining pure indigo is by sublimation. Take 20 or 30 grains of pulverized common indigo and place it in an iron spoon, which must be gradually heated to 500 or 600° Fahrenheit. A purple smoke will then exhale copiously, and at the same time a fine tissue of small, shining, silky needles will start up on the surface of the indigo. These may be withdrawn by the

point of a knife; they are crystals of sublimed indigo.

Precipitated and *sublimed* indigo appear by the chemical tests to be constituted of the same elements; and no doubt is entertained that they present the pure colouring matter of indigo in its most concentrated form.

Three chemists have published analyses of pure indigo within the last three years; namely, Drs. Thomson and Ure, and Mr. W. Crum, all of Glasgow. The same plan was adopted by all three, namely, burning a small given portion of indigo in contact with the black oxide of copper in green glass tubes. The indigo being finely divided and intimately diffused through a comparatively large portion of the oxide, heat is applied sufficient to burn the carbone and hydrogen of the indigo, and to liberate the azote; hence from the quantities of carbonic acid and azote produced, and the loss of weight which the oxide sustains, the constituents of indigo are inferred. The results are below:

	Dr. Thomson*	Dr. Ure†	Mr. Crum‡
Carbone	40.39.....	71.37.....	73.22
Azote	13.46.....	10.—.....	11.26
Oxygen	46.15.....	14.25.....	12.60
Hydrogen	0	4.38..	2.92
	100	100	100

* Annal. of Philos. June, 1820——‡Ibid. Feb. 1823.
† Philos. Trans. 1823.

It is observable that the results of Dr. Ure and Mr. Crum present no remarkable differences, except in regard to hydrogen; whilst Dr. Thomson finds no hydrogen; and remarkable differences between his results and those of the other two are found in the articles carbone and oxygen.

The atomic constitution of indigo by the above authors is as follows:

	Dr. Thomson	Dr. Ure	Mr. Crum
Carbone	7 atoms.....	16 atoms.....	16 atoms
Oxygen	6 do.	2 do.	2 do.
Azote	1 do.	1 do.	1 do.
Hydrogen	0 do.	6 do.	4 do.
	14	25	23

I am inclined to think the analysis of Mr. Crum as likely to be an approximation to the constitution of pure indigo as either of the other two: and I should adopt his atomic constitution if he would modify it so as to adopt my weight of the atom of azote instead of its double, which has somehow got into common reception as a substitute without any sufficient reason that I can find. If we adopt my weight for azote, Mr. Crum's atoms will become 16, 2, 2, and 4; which being all devisible by 2, become

8 atoms carbone
1 atom oxygen
1 atom azote
2 atoms hydrogen

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This simplification of the atom of Indigo I suggested to Mr. Crum in a conversation we had together, and he seemed inclined to adopt it. Referring therefore to my scale of atomic numbers, we shall have the atom of pure indigo to consist of

8 atoms carbone	5.4	=	43.2	.....75.5
1 atom oxygen	7	=	7	... .12.3
1 atom azote	5	=	5	..... 8.7
2 atoms hydrogen	1	=	2	..... 3.5
			57.2	100

Mr. Crum in his very ingenious essay above referred to, finds that a compound of 1 atom of indigo and 1 of water, may be formed by means of sulphuric acid; he denominates it *phenicin;* it may perhaps be better designated by the name of proto-hydrate of indigo. The common product of sulphuric acid and indigo, or *sulphate of indigo* of Dr Bancroft, he calls *cerulin*, and finds it to be a compound of 1 indigo and 2 water, or the deuto-hydrate of indigo.

I have made no attempts myself to analyse pure indigo into its constituent elements; but have often tried, both recently and some years ago, to find the quantity of oxygen required to convert the green indigo solutions in lime water into blue indigo. The results have

been pretty uniformly the same; namely, that the oxygen which combined with the green indigo, to convert it to blue, was about $\frac{1}{7}$ or $\frac{1}{8}$ of the whole weight of the resulting indigo; and hence I concluded, on the supposition that one atom of oxygen was added to one of indigo, that the atom of indigo must weigh about 50, or 56, and this conclusion I pointed out to Mr. Crum, as corroborating his analysis. The quantity of oxygen required was much less, and of course the weight of the atom of indigo was much greater, than I had anticipated.

We now proceed to the consideration of the best means of fixing a comparative value upon the different samples of the indigo of commerce. After numerous trials I find the method first suggested by Decroisille* to judge of the strength of oxymuriatic acid to be preferred. The objects indeed are different, but the operations are analogous: he made use of a given solution of indigo to ascertain the comparative strengths of various solutions containing oxymuriatic acid; on the other hand, I propose to use a solution of oxymuriatic acid of known strength, to compare the relative quantities of pure indigo in different samples.

* Annales de Chimie, Tom. 2. p. 177.

In the 1st vol. of the Annals of Philosophy (1813) I pointed out a safe and easy method of estimating the quantity of oxymuriatic acid, in solutions of oxymuriate of lime, not by solutions of indigo, which must be variable from the quality of the indigo, but by solutions of protosulphate of iron, which can always be obtained of the same strength. I say *safe* and *easy* method, notwithstanding we are gravely told by one professor of chemistry, that he had tried the method and was nearly killed by it; and another states that he had attempted to follow my method, but did not succeed. Any person who is tolerably skilled in chemical manipulations, and has the two liquids, sulphate of iron of a known strength, and oxymuriate of lime of a known specific gravity, before him, may determine the strength of the oxymuriate in the space of five minutes. In this time I found the strength of the oxymuriate of lime used on the present occasion. Having by me a solution of protosulphate of iron containing 8 per cent. oxide, I took 50 grain measures of it and poured them into a wine glass, then 100 of the oxymuriate, stirring the mixture, after which no smell was perceived; 100 more were poured in, still no smell; then dropped in ten grains at a time by a dropping tube, stirring

the mixture each time; the fifth 10 grains produced a slight but transient smell; the sixth a strong and permanent smell. Hence 250 were required to saturate 50 of the sulphate. The oxide (4 grains) being divided by 9, gives .444 for the weight of oxygen in 250 oxymuriate, or .17 parts of a grain of oxigen are imparted by each hundred of the liquid.

In the essay above referred to I mentioned another method of investigating the value of oxymuriate of lime solution. But, owing to the then prevailing erroneous notion on the proportion of the elements of nitric acid, no satisfactory application could be made of it. I now find that oxymuriate of lime converts nitrous gas into nitric acid immediately, and hence this operation may be used with great elegance and precision to shew the real quantity of oxymuriatic acid in solutions.

For example: I took a graduated tube of capacity equal to 300 grains of water; I filled it with pure nitrous gas, and then transferred it to a cup of the liquid oxymuriate, valued above by the sulphate of iron. After repeated agitation, covering the end of the tube carefully with my finger, I soon had 100 measures of liquid in the tube: then withdrawing it to a cup of water I

agitated repeatedly, letting in water each time, instead of oxymuriate of lime, because I was aware that the 100 measures already in the tube were not saturated. Soon after, the process was at an end, no more nitrous gas being absorbed. The 100 measures of the oxymuriate took 168 measures of nitrous gas to saturate them. Now deducting $\frac{1}{10}$ of this for the nitrous gas impregnating the liquid, and for loss occasioned by the free oxygen gas in the water which the nitrous gas had to combine with, there will remain 157 nitrous gas = .2 grain weight, which was converted into nitric acid; but if we deduct $\frac{1}{7}$ part from the weight of nitrous gas, we shall have the weight of oxygen requisite to convert it into nitric acid = .175 parts of a grain; only differing $\frac{2}{1000}$ from the other valuation by sulphate of iron.

To find the value of any sample of Indigo, I take one grain carefully weighed, from a mass finely pulverized. I put this into a small glass, a wine-glass for example; then by a dropping tube I put 2 or 3 grains of concentrated sulphuric acid upon it. The two principles are next well mixed together by trituration with the end of a small glass rod. Water is then poured in and the colouring matter fully diffused through it.

The liquid is now transferred into a tall cylindric jar, of about 1 inch internal diameter; more water is poured in till the mixture becomes sufficiently dilute to shew the figure of the flame of a candle through it Then the liquid oxymuriate is mixed with the liquid gradually and by measure, agitating duly each time, and never putting any more in till the smell of the preceding has vanished. The liquid soon becomes transparent and of a beautiful greenish-yellow appearance: after the dross has subsided, the clear liquid may be poured off, and a little more water put to the sediment, with a few drops of oxymuriate of lime, and a drop of dilute sulphuric acid; if more yellow liquid is produced, it arises from particles of indigo which have escaped the action of the oxymuriate before, and must be added to the rest.

The value of the indigo I consider in proportion to the quantity of real oxymuriate of lime necessary to destroy its colour. The value also may be well estimated by the quantity and intensity of the amber-coloured liquid which the indigo produces, and this is found independently of any valuation of the oxymuriate of lime.

Some of the samples I have tried and the results are as under:

1.—*Precipitated* and *sublimed* Indigo, each 1 grain, gave nearly the same results. Each of these required 140 grains of the oxymuriate of lime solution, corresponding to .25 parts of a grain of oxygen. The yellow liquid obtained was 3600 grains.

2.—Flora Indigo, 1 grain, required 70 of the oxymuriate, = .125 parts of a grain of oxygen, or one half of the other.

The same result from a sample marked *J. R. best.*

3.—Indigoes marked 1 *P* and 3 *P* required about 60 of the oxymuriate.

4.—Those marked *J. R. middle, J. R. worst,* and 4 *P,* required about 50 oxymuriate.

5.—That marked *Wood* was rather inferior to the above, but required above 40 oxymuriate.

6.—Those marked 2 *P* and 1194, were the lowest I have examined; 1 grain of each did not require more than 30 oxymuriate, or 35 at the most. A poor turbid yellow liquor was produced. The sample 2 *P,* when burned, yielded about 30 per cent. of fine sand.

Upon a review of these experiments, I am persuaded that to destroy indigo by oxymuriatic acid, *twice* the quantity of oxygen is necessary that is required to revive it from the lime solution.

I hope the subject here taken up will not be considered as unimportant, when we are informed that the article *Indigo* imported into this country annually, about 15 years ago, amounted in value to upwards of two millions of pounds sterling; and it much exceeds that sum in all probability at the present time.

OBSERVATIONS

CONDUCIVE

TOWARDS

A MORE COMPLETE HISTORY

OF THE

CUCKOO.

BY MR. JOHN BLACKWALL.

(*Read Nov. 28th*, 1823.)

DURING a period of more than two thousand years, from the time of Aristotle, the father of natural history, to the year 1788, when the excellent observations of Mr. afterwards Dr. Jenner, so justly celebrated for the introduction of vaccination, were published in the Transactions of the Royal Society,* the history of the cuckoo, if it deserved the appellation, consisted of a tissue of extragavant fables, very sparingly interspersed with facts. It will not be necessary to particularize the many fanciful conjectures transmitted to us by the ancients respecting this bird, as they have been repeatedly no-

* Vol. LXXVIII. Pt. 2.

ticed by authors of eminence, and are sufficiently well known to the classical ornithologist. It may be observed, however, that so profound has been the veneration of succeeding ages for the opinions of antiquity, and so unbounded the confidence in the accuracy of those collected by Aristotle on this particular subject, that, notwithstanding the great absurdity of some of them, they long continued to maintain the reputation they had acquired, a few slight additions and corrections only having been made by more modern writers, till the publication of Mr. Jenner's interesting discoveries: indeed, almost the only facts in the obscure history of this singular species, that seem to have been known with any tolerable degree of certainty, even towards the close of the eighteenth century, were, that cuckoos appear and disappear periodically; that the call from which they take their name is peculiar to the male; that the female lays in the nests of other birds; that those birds carefully bring up the young cuckoo, which has a weak, plaintive chirp, and is very different in plumage from the old ones; and that it is generally observed to be the sole occupier of the nest. In this state the history of the cuckoo remained, when Mr. Jenner, at the request of Mr. John Hunter,

undertook to investigate the habits and economy of this extraordinary bird, and in the course of his researches, which were conducted with great care and assiduity, he discovered a number of curious facts, scarcely less wonderful than the marvellous but visionary speculations of the ancients themselves. The following brief abstract will serve to convey some idea of what his skill and industry effected.

Mr Jenner informs us, that the first appearance of cuckoos in Gloucestershire, where his observations were made, is about the 17th of April. The song of the male, which is well known, soon proclaims his arrival: that of the female (if the peculiar notes of which it is composed may be so called) is widely different, and has been so little attended to, that few are acquainted with it; it is thought, however, to bear some resemblance to the cry of the little grebe.

Unlike the generality of birds, cuckoos do not pair, and as their eggs are seldom met with till about the middle of May, it is supposed that the females do not begin to lay till some weeks after their arrival. Cuckoos deposit their eggs in the nests of a great variety of small birds, intrusting them to the care of the hedge warbler, pied wagtail,

titlark, yellow bunting, green grosbeak, whinchat, &c. Among these, they usually select the three first, but shew a much greater partiality to the hedge warbler than to any of the rest. The hedge warbler commonly takes up four or five days in laying her eggs, and during this time (generally after she has laid one or two) the cuckoo contrives to deposit hers among the rest. This intrusion often occasions some discomposure, for the old hedge warbler at intervals, whilst she is sitting, not unfrequently throws out some of her own eggs; and sometimes injures them in such a way that they become addle; however, she is rarely observed to throw out or injure that of the cuckoo. She continues to sit the same length of time as if no foreign egg had been introduced, the cuckoo's requiring no longer incubation than her own; nay, it frequently happens that it is hatched first. The titlark is often selected by the cuckoo to take charge of its offspring, but as it is a bird less familiar than many that have been mentioned, its nest is not so often discovered.

The young cuckoo, soon after it is excluded from the egg, commences the extraordinary practice of turning out its companions, which are usually left to destruction. The mode of accomplishing this is very curious:

with the assistance of its rump and wings, it contrives to get a young bird upon its back, and making a lodgment for the burden by elevating its pinions, clambers backward with it up the side of the nest till it reaches the top, where resting for a moment, it throws off its load with a jerk, and quite disengages it from the nest. It remains in this situation a short time, feeling about with the extremities of its wings, as if to be convinced whether the business is properly executed, and then drops into the nest again. It frequently examines, as it were, an egg or nestling with the ends of its wings before it begins its operations; and the nice sensibility which these parts appear to possess, seems sufficiently to compensate for the want of sight, of which sense it is at first destitute. It is wonderful to see the extraordinary exertions of the young cuckoo, when it is two or three days old, if a bird be put into the nest that is too weighty for it to lift out. In this state it seems ever restless and uneasy, but this disposition for turning out its companions continues to decline, from the time it is two or three, till it is about twelve days old, when it usually ceases: indeed, the disposition for throwing out the egg appears to cease a few days sooner, for the young cuc-

koo, after it has been hatched nine or ten days, will frequently remove a nestling that has been placed in the nest with it, when it will suffer an egg, put there at the same time, to remain unmolested. The singularity of its shape is well adapted to these purposes, for, different from other newly hatched birds, its back from the scapulæ downwards is very broad, with a considerable depression in the middle, which seems formed by nature for the design of giving a more secure lodgment to any object that the young cuckoo may be desirous of removing from the nest. When it is about twelve days old, this cavity is quite filled up, and then the back assumes the shape common to nestling birds in general. The same instinctive impulse which directs the cuckoo to deposit her eggs in the nests of other birds, directs her offspring to throw out the eggs and young of the owners of the nests. The scheme of nature would be incomplete without it, for it would be extremely difficult, if not impossible, for the small birds, destined to find support for a young cuckoo, to find it for their own young ones also, after a certain period; nor would there be room for the whole to inhabit the nest.

The eggs of the cuckoo are remarkably small in proportion to the size of the bird;

they also vary considerably in size, weight, and colour. It sometimes happens that two are deposited in the same nest, and cuckoos' eggs are frequently hatched in the nests of other birds, after the birds that laid them have disappeared.

There is certainly, Mr. Jenner observes, no reason to be assigned from the formation of the cuckoo, why, in common with other birds, it should not perform the several offices of aidification, of incubation, and of rearing its young; for it is in every respect perfectly formed for collecting materials and constructing a nest: neither its external shape nor internal structure prevent it from hatching its eggs: nor is it by any means incapacitated from bringing food to its young. To what cause then, he inquires, must we attribute the singularities of this bird? May they not be owing to the following circumstances? The short residence it is allowed to make in the country where it is destined to propagate its species, and the call that nature has upon it, during that short residence, to produce a numerous progeny. The cuckoo's first appearance in Gloucestershire is about the middle of April, commonly on the 17th: its egg is not ready for incubation till some weeks after its arrival, seldom before the middle of

May: a fortnight is taken up by the sitting bird in hatching the egg: the young bird generally continues three weeks in the nest before it flies: and the foster parents feed it more than five weeks after this period; so that, if a cuckoo should be ready with an egg much sooner than the time pointed out, not a single nestling, even of the earliest, would be fit to provide for itself, before its parent would be instinctively directed to seek a new residence; and would be thus compelled to abandon its young one; for old cuckoos take their final leave of this country in the first week of July.

If nature had allowed the cuckoo to stay here as long as some other migratory birds, which produce a single set of young ones, (as the swift or nightingale, for example) and had allowed it to rear as large a number as any bird is capable of bringing up at one time, these might not have been sufficient to answer her purpose; but by sending the cuckoo from one nest to another, it is reduced to the same state as the bird whose nest is daily robbed of an egg, in which case the stimulus for incubation is suspended. Of this we have a familiar example in the common domestic fowl. That the cuckoo actually lays a great number of eggs, dissection seems to

prove very decisively. Upon comparing the ovarium, or racemus vitellorum, of a female cuckoo, killed just as she had begun to lay, with that of a pullet killed just in the same state, no essential difference appeared: the uterus of each contained an egg perfectly formed, and ready for exclusion; and the ovarium exhibited a large cluster of eggs gradually advanced from a very diminutive size, to the greatest the yolk acquires before it is received into the oviduct. The appearance of one killed on the third of July was very different. In this a great number of the membranes which had discharged yolks into the oviduct might be distinctly traced, and one of them appeared as if it had parted with a yolk on the preceding day. The ovarium still exhibited a cluster of enlarged eggs, but the most forward of them was scarcely larger than a mustard seed.

It plainly appears, Mr. Jenner remarks, that birds can keep back or bring forward their eggs (under certain limitations) at any time during the season appointed for them to lay; but the cuckoo, not being subject to the common interruptions, goes on laying from the time she begins, till the eve of her departure from this country; for, although old cuckoos generally take their leave in the first week of July, yet instances are not wanting of eggs having

been hatched so late as the middle of that month.

Among the many peculiarities of the young cuckoo, there is one that shews itself very early. Long before it leaves the nest, it frequently, when irritated, assumes the manner of a bird of prey, looks ferocious, throws itself back, and pecks at anything presented to it with great vehemence, often, at the same time, making a chuckling noise, like a young hawk. Sometimes, when disturbed in a smaller degree, it makes a kind of hissing noise, accompanied with a heaving motion of the whole body.

Its chirp is plaintive, like that of the hedge warbler, but the sound is not acquired from the foster parent, as it is the same whether it be reared by the hedge warbler, or by any other bird. It never acquires the adult note during its stay in this country.

The growth of the young cuckoo is very rapid, and as it is fed for a long period by the small birds that have the care of it, they frequently have to perch on its back, or half expanded wing, in order to gain a sufficient elevation to put the food into its mouth.

There seems to be no precise time fixed for the departure of young cuckoos. Probably they go off in succession, as soon as they are capable of taking care of themselves; for though

they stay here till they become nearly equal in size, and growth of plumage, to old ones, yet in this very state, the care of their foster parents is not withdrawn from them. If they did not go off in succession, it is probable that we should see them in large numbers by the middle of August; for as they are to be found in great plenty, when in a nestling state, they must then appear very numerous, since all of them must have quitted the nest before that time; but this is not the case, for they are not more numerous at any season, than the parent birds are in the months of May and June.

Such are the most important particulars which have resulted from Mr. Jenner's well conducted inquiry, and to the accuracy of the greater part of them I can unite my testimony with that of others, though, in a few instances, our opinions do not entirely coincide.

Mr. Jenner states, that cuckoos continue to lay regularly from the exclusion of the first egg to the time of their departure, and supposes that they are enabled to do so by intrusting the care of their progeny to strangers; being placed by this circumstance, he observes, in a similar situation to the bird whose nest is daily robbed of an egg. Now

if Mr. Jenner means to assert (and this, I think, is the only rational explanation that his language admits) that birds, during the breeding season, can produce eggs at will, and that they may be excited to lay in succession many more than their usual number, by daily removing one from their nests, he is certainly mistaken: Colonel Montagu's experiments,* as well as my own, decidedly prove the contrary, both with regard to wild and domestic birds.

As cuckoos deposit a single egg only in the same nest, they have been thought, by most persons, to lay no more than one. Mr. Jenner, on the contrary, supposes, from an examination of the ovary in a bird that had just commenced laying, and from having observed that cuckoos' eggs are occasionally laid about the time that the old birds disappear, that they produce a large number. With due deference to such high authority as Mr. Jenner, I think there are sufficient reasons for believing, that both these extremes are erroneous. According to Montagu,† whose opinion is founded on the dissection of breeding females, cuckoos lay from four to six eggs;

* Ornithological Dictionary, Introduction, p. 10, and following.

† Ornithological Dictionary, Introduction, p. 8, and following.

and this is probably near the truth. In females opened when they had just begun to lay, only four or five eggs were usually discovered, that could possibly be laid in succession; from the smallest of which, to what may be termed the secondary eggs, there was a sudden break off,—not a gradual decrease in size. The scarcity also of the eggs and young of this species, even in its favourite haunts, tends powerfully to confirm the opinion, that Mr. Jenner has greatly overrated its fecundity.*

It is possible, that those cuckoos that arrive early may sometimes lay two sets of eggs during their stay with us; but then we may safely conclude, that a considerable interval of time always elapses between the production of the first and second sets; and it is quite as probable that those eggs which are occasionally found in July, should be laid by birds that arrive late, as by early coming birds that produce more than one set of eggs; for cuckoos come and go in succession, some individuals appearing three weeks, or even a month before others: besides, it may fre-

* White Moss, a bog of considerable extent, situated about four miles to the N. E. of Manchester, is a very favourite resort of cuckoos; yet the turf cutters inform me, that even in the most favourable seasons they never knew of more than five or six eggs belonging to this species in different nests at the same time.

quently happen, that many females have not an opportunity of forming a connection with the other sex till long after their arrival; for though it is generally asserted that cuckoos do not pair, and hence it may be inferred that the intercourse between the sexes must be greatly facilitated, yet the accurate observations of my friend R. G. Baker, Esq. certainly render this opinion doubtful. In the spring of the present year (1823) he noticed that a pair of cuckoos frequented the same spot for more than a fortnight, and were so jealous of the approach of any other bird of the same species, that they constantly united their efforts to drive away an intruder, and always with success. I may add, that the male was distinguished from every other in the vicinity by the deepness of his note. This unquestionably looks like pairing, and should at least prevent a hasty decision on a point that deserves further investigation.

Colonel Montagu, from the extraordinary fact related by Mr. Jenner, of two hedge warbler's eggs containing living fœtuses having been found under a young cuckoo about a fortnight old, and from the difficulty which he supposes cuckoos would have in meeting with nests in a suitable state to receive their eggs, if they were compelled to lay them in

regular succession, conjectures, that contrary to the generality of birds, they have the power of retaining the egg in the uterus after it is perfected, and that while it remains there, the embryo is progressively advanced towards maturity by the internal heat of the parent's body.* Now, without having observed a single circumstance in the whole course of my inquiries that at all tended to corroborate this opinion of Montagu's, I have discovered a curious fact, which appears to render such a supposition altogether unnecessary. On the 5th of May, 1822, I saw a cuckoo in the act of watching a pair of titlarks construct their nest. The larks had just commenced building, and did not seem to be at all disconcerted at the presence of the cuckoo, which sat on the ground about seven or eight yards from the spot, attentively observing them; and, when disturbed, flew away with great reluctance, and only to a short distance. This nest, which was on Kersal Moor, where the races are annually held, was too distant from my residence to permit me to examine it frequently, and to make such numerous and minute observations as I wished; but on the 12th of May I again visited it, in the confident expectation that it

* Ornithological Dictionary, Introduction, p. 15.

would contain a cuckoo's egg, and I was not disappointed. I may further remark, in confirmation of this discovery, which, by exhibiting a curious, and hitherto unnoticed, instinctive propensity of this bird, forms an interesting addition to its history, that cuckoos almost invariably deposit their eggs in the nests of other birds, as soon as those birds begin to lay; not unfrequently indeed, immediately after the exclusion of the first egg; and Mr. Baker informs me, that he saw the hen of that pair of cuckoos which he observed so closely last spring, fly directly to a titlark's nest, as to a place with which she was perfectly familiar, though he had never seen her there before, and after raising her head, and looking round, as if to ascertain whether she was noticed, went and deposited her egg in the nest, before the larks had begun to lay. From these circumstances, and from the direct evidence of my own senses, I consider this fact then as satisfactorily established, and it is of importance, in as much as it completely obviates a difficulty which has greatly perplexed modern ornithologists, and which chiefly induced Colonel Montagu to form his extraordinary, but gratuitous opinion, respecting the power of the

cuckoo to retain its egg till it meets with a nest in a suitable state to receive it.

Though Mr. Jenner enumerates a variety of small birds in whose nests cuckoos deposit their eggs, yet he remarks, that in Gloucestershire they give a decided preference to that of the hedge warbler. In this neighbourhood, where titlarks are numerous, their nests are usually selected for this purpose, and perhaps would be so very generally, were they equally abundant in all situations; as, from being built on the ground, they are much more accessible to so large a bird as the cuckoo, than that of the hedge warbler, which is frequently placed in close thorn hedges, or thick bushes. If cuckoos laid in the nests of large birds, their young would not be able to dispossess their companions, and would probably soon perish for want of proper food.

It is now well known, that cuckoos, in proportion to their size, lay remarkably small eggs, which vary considerably both in magnitude and colour; but as very inaccurate representations and descriptions have frequently been given of them, I have had coloured engravings of the most usual varieties, made from drawings of good specimens. (*See the annexed plate.*)

The following Table exhibits the mean weight of the cuckoo, and of several birds in whose nests it most frequently lays: also the mean weight of their eggs, with the ratio of the weight of each bird to that of its egg, omitting fractions.

TABLE.

BIRDS.	Mean weight in grains.	Mean weight of their eggs in grains.	Ratio of Birds to their eggs, in weight
Cuckoo.....	2297	55	$\frac{1}{41}$
Titlark.....	259	35	$\frac{1}{8}$
Lesser Fieldlark	354	37	$\frac{1}{9}$
Yellow Bunting	412	43	$\frac{1}{9}$
Hedge Warbler	332	35	$\frac{1}{9}$
Pied Wagtail ...	333	37	$\frac{1}{9}$

If it be admitted, as I believe it safely may, that cuckoos lay from four to six eggs, it will not be difficult to furnish data from which a rude estimate may be made of the mean annual destruction occasioned by young cuckoos among small birds in England and Wales. Early in May, before cuckoos have begun to breed, and before the foliage of forest trees has been sufficiently expanded to afford them shelter and concealment, I have known nine or ten of these birds come in an evening to roost among the evergreens in the plantations

immediately adjoining our family residence; and as I am certain that all the cuckoos belonging to the township of Crumpsall, in which it is situated, did not come to roost with us on these occasions, and as it is very probable that I did not see all that did come, I think, though the number of males is reported to exceed that of females, that four will not be considered a high average for the latter in Crumpsall, which contains 3,301,816 square yards, nor three too high as a general average for an equal area; since Mr. Jenner remarks, that cuckoos are numerous in Gloucestershire, and Colonel Montagu states that they are plentiful in Devonshire;* and I know from my own observation, that they are much more abundant in many parts of Lancashire, Cheshire, Derbyshire, Staffordshire, Warwickshire, and also in Westmoreland and Cumberland, especially in the neighbourhood of the Lakes, than they are with us. I am informed likewise, that they are very plentiful in Yorkshire, and also in the principality of Wales. The mean number of eggs laid by those birds that are usually selected by the cuckoo to provide for its progeny is five. Now according to Pinkerton,

* Ornithological Dictionary, Introduction, p. 10.

the area of England and Wales is 49,450 square miles; which reduced to square yards gives 153,176,320,000. This, divided by 3,301,816 square yards, the area of the township of Crumpsall, and the quotient multiplied by 3, the mean number of hen cuckoos for every 3,301,816 square yards, gives 139,173, the mean annual number of female cuckoos that visit England and Wales; which multiplied by 5, the mean number of eggs laid by the cuckoo, gives 695,865, the number of nestlings produced annually by the mean number of females; and this product multiplied by 5, the mean number of eggs laid by those birds to whose care cuckoos usually intrust their offspring, gives 3,479,325, the mean annual number of nestling birds destroyed by young cuckoos in England and Wales. Enormous as this destruction appears, it is probably rather under than overrated, and when compared with that occasioned by cuckoos in general, or by our British species alone, in the various countries in which it breeds, it sinks into absolute insignificance.

The injuries which so frequently happen to the eggs of those birds in whose nests cuckoos lay, are occasioned, as I have often proved experimentally, by the sitting bird,

in attempting to accommodate herself to eggs of different sizes. If comparatively large and small eggs are placed in the same nest, some of the smaller ones are generally thrown out, or rendered addle, by the hen bird, in endeavouring to arrange them so that she may distribute nearly an equal degree of warmth and pressure to all; but the larger ones, which chiefly sustain her weight, and, consequently, are less liable to be moved, usually remain unmolested. When the eggs of birds are exchanged for others of a uniform magnitude, whether larger or smaller than their own, provided the difference is not so great as to occasion them to be forsaken, no disturbance ensues, whatever their colour may be, the change either not being perceived, or totally disregarded; and the young when extruded, are attended with the utmost care and solicitude.

Cuckoos generally use the precaution of waiting for the absence of small birds from their nests before they venture to lay in them: sometimes, however, their approach is perceived, when the owners immediately make every effort to repel them, but do not always succeed, as the following instance evinces. On the evening of the 24th of June, 1814, I saw a hen cuckoo alight in a field of mowing

grass, when a pair of titlarks attacked it with such fury, that they pulled several small feathers off it. Their loud cries and violent gesticulations attracted the notice of several people at work near the spot, who by throwing stones at the cuckoo drove it to some distance: however, it soon returned, and though repeatedly annoyed, persevered till it ultimately accomplished its purpose, by laying in the nest of the larks. As this bird was on the very eve of its departure, for I did not see a single old cuckoo that year after the 25th of June, the case was an urgent one, and may account for its unremitted exertions. This fact proves also, how very late in the season cuckoos' eggs are occasionally laid.

On the 30th of June last, (1823,) I took a young cuckoo that was hatched in a titlark's nest, on White Moss, on the 28th: seven days after old birds had quitted that neighbourhood; and this nestling, while in my possession, turned both young birds and eggs out of its nest, in which I placed them for the purpose, and gave me an opportunity of contemplating at leisure the whole process of this astonishing proceeding, so minutely and accurately described by Mr. Jenner. I observed, that this bird, though so young, threw itself backwards with considerable force when any thing touch-

ed it unexpectedly. It died on the 2nd of July, the fifth day after it was hatched, and then weighed 318 grains.

Young cuckoos are so very different from adults, that they have been described by several authors as a distinct species. In the colours of their plumage, and in their eyes, they bear some resemblance to young kestrils; while the old birds, in both these particulars, are very similar to the male sparrow-hawk after the third or fourth moult. As young cuckoos do not acquire their mature plumage while they remain in this country, though they are sometimes seen here in September, two months later than old birds, and as they are never found in their first feathers on their return in spring, they must moult during their absence: which clearly proves that they are migratory; as it is hardly possible that they should acquire fresh feathers in a state of torpidity. This fact is further corroborated by the early departure of the old birds, which takes place when the temperature is approaching the maximum for the year, and, consequently, when it is much higher than at the time of their arrival: and it is evident that they cannot become torpid with an increasing temperature: indeed, the young birds, which stay so long after them, instead of dis-

playing symptoms of debility and torpor, continue to advance progressively in growth and vigour. Cuckoos, at a mean of ten years' observations, appear in this neighbourhood on the 22nd of April, when the temperature of the air is 48° in the shade, and quit it on the 26th of June, when the temperature is 57°.

It has been asserted, that cuckoos sometimes incubate their own eggs, and bring up their own young; but all the instances brought forward in support of this opinion, except one, are totally undeserving of notice; and this might have been passed over without comment also, if Dr. Darwin,* the Hon. Daines Barrington,† and the Rev. W. Bingley,‡ had not seemed to consider it conclusive and incontrovertible. The circumstance is thus related by Darwin. "As the Rev. Mr. Stafford was walking in Glossop Dale, in the Peak of Derbyshire, he saw a cuckoo rise from its nest. The nest was on the stump of a tree, that had been some time felled, among some chips that were in part turned grey, so as much to resemble the colour of the bird. In this nest were two young cuckoos: tying a

* Zoonomia, Vol. 1. p. 172-3.

† Miscellanies, p. 255.

‡ Animal Biography, Vol. II. p. 299, 300.

string about the leg of one of them, he pegged the other end of it to the ground, and very frequently for many days beheld the old cuckoo feed these her young, as he stood very near them." That Mr. Stafford must have been mistaken needs scarcely to be insisted on, since Mr. Jenner has shewn, that when two young cuckoos happen to be hatched in the same nest, the stronger invariably turns out the weaker. The nest which Mr. Stafford found, from the number of young it contained, most probably belonged to a goatsucker, as I know that this species, which seldom lays more than two or three eggs, breeds in the neighbourhood of Glossop; and it might easily be mistaken for a cuckoo, by a person not very familiar with birds, who had only an opportunity of observing it at a distance. If this gentleman had been a good ornithologist, would he not have endeavoured to remove every possibility of doubt in a matter which, it is evident, greatly excited his interest, by examining and describing the structure of the feet of these young birds?

Male cuckoos, a short time before they retire, entirely lose their cry, and this loss is generally preceded by stammering and a difficulty of utterance. Now as most of our singing birds become mute in autumn, solely

from inability to continue their songs, as is manifest from their unavailing efforts to prolong them, whatever occasions their silence, most probably occasions that of the cuckoo also, and I conceive that an efficient cause will be found in the propagation of their species, and in the decrease of their food, which, by relaxing the vocal organs, renders them incapable of obeying the dictates of the will. The well known cry of the male cuckoo is frequently heard in the night.

Various are the modes of accounting for the peculiarities of the cuckoo adopted by different writers on the subject. Some, who have turned their attention particularly to the anatomy of this bird, think they have discovered a satisfactory reason for its not hatching its own eggs, in the largeness and protuberance of its stomach, which they hastily conclude must render the act of incubation difficult, if not impracticable; but when we consider that several birds, as the owl, goatsucker, &c., whose stomachs are, in these respects, similar to that of the cuckoo, do incubate their own eggs, the insufficiency of this imaginary cause will be very apparent.

Buffon supposes that female cuckoos lay their eggs in the nests of other birds, to prevent the males, which he states occasionally

prey upon eggs, from destroying them.* The chief objection to this supposition arises from the deficiency of evidence in support of this charge brought against the males.

According to the Physiognomical System of Drs. Gall and Spurzheim, cuckoos transfer the care of their progeny to strangers, in consequence of the imperfect developement of certain cerebral organs, termed by these authors, organs of constructiveness and philoprogenitiveness, whose functions are thus necessarily circumscribed. I shall not here discuss the merits of this system, which, notwithstanding the ridicule that is bestowed upon it, is at least entitled to a patient and candid investigation, but shall proceed to consider the reason assigned by Mr. Jenner for the singularities of the cuckoo, which to me appears perfectly satisfactory. This gentleman conjectures, as I have already stated, that the short stay which cuckoos make in this country is the true reason why they do not bring up their own young, as the parent birds would be impelled by a propensity to migrate, to quit their progeny before they were able to provide for themselves. This, as far as regards the British species, certainly seems to be a very sufficient cause:

* Histoire Naturelle des Oiseaux. Tome sixième.

in what degree it is applicable to foreign species, of which Dr. Latham, in his General History of Birds, now publishing, enumerates about 87, besides varieties, is an interesting inquiry, which our present very imperfect knowledge of their habits and economy will not permit us to answer. Dr. Latham, indeed, does not particularize more than five or six species belonging to this extensive genus, that lay in the nests of other birds, nor more than twice this number that bring up their own young, and of the manners and propensities of the rest we are almost entirely ignorant.

It is reported that the cowpen oriole, a bird perfectly distinct from the cuckoo, has many of its most remarkable peculiarities, intrusting the care of its offspring to strangers, and laying only one egg in the same nest. Dr. Darwin, in his Zoonomia, maintains that the propensities of the cuckoo to lay in the nests of other birds, and to migrate, are not instinctive; and goes so far as to reflect upon the reasoning powers of those who entertain a contrary opinion. But the Doctor, though a profound scholar, and a close observer of nature, was not infallible; and it would be easy to point out numerous errorsi nto which he has fallen, in his very in-

genious and amusing work, especially in the section on instinct. I shall, however, in this instance, content myself with exhibiting the erroneousness of his opinions respecting the cuckoo; which will be best done by tracing the progress of an individual of this species, from its extrusion from the egg, till it arrives at maturity, or begins to propagate its kind; since an examination of its various means of acquiring information on those subjects which are of the greatest importance for it to know, will furnish the surest criterion of what is due to nature, and what to observation and tuition. Let us suppose then, that a cuckoo's egg is hatched in the nest of a titlark about the middle of June. No sooner is the young bird disengaged from the shell, than a disposition to eject whatever happens to be in the nest with it begins to manifest itself; and as young cuckoos increase in size and strength very rapidly, it is soon enabled to turn out the nestling larks, which are suffered to perish within a few inches of the nest, being entirely abandoned by their parents. Now to what cause, I would ask, must we attribute this extraordinary propensity, which shews itself so early? As titlarks do not possess it, and as old cuckoos, after they have deposited their eggs in suitable nests,

interest themselves no further about their progeny, it is evident that it cannot be acquired from them; it must, therefore, be perfectly innate. It may be remarked also, that the chirp of young cuckoos is the same, as Mr. Jenner rightly observes, whatever the species of their foster parents may be: hence it follows that it is not learned from any other bird, but is exclusively their own. After remaining in the nest about three weeks, this young bird deserts it early in July, and begins to acquire the use of its wings; but the care of the titlarks is not entirely discontinued till towards the middle of August; when having obtained a considerable command of wing, a propensity to migrate prompts it to leave the country. The instinctiveness of this propensity one would be inclined to believe could not admit of a doubt; for titlarks are not birds of passage, and as old cuckoos depart late in June, or early in July, it is clear that young ones cannot derive any benefit from their experience: yet Darwin maintains, that migration among birds is as much an acquired art as navigation is among men. With regard to the cuckoo, I trust that I have said sufficient to convince every impartial inquirer, that it is actuated in this particular purely by instinct; and, reasoning from analogy, I should be led

to conclude that this is the case with all migratory birds without exception. But to return to the cuckoo. Early in the ensuing spring, it revisits the country where it was bred, or seeks another equally well suited to its habits and necessities. If a male bird, its well known cry, that is now heard for the first time, and which I need scarcely observe cannot have been taught it, at once distinguishes its sex. If a female, it is solicitous after impregnation, to secure a suitable asylum for its offspring; and here, though Darwin denies it, the operations of instinct are most strikingly manifested. Without any previous instruction, it discovers the nests of other birds, though it constructs none itself, by watching the birds build them; and selecting such only, as from the size of the owners, and their manner of feeding, are best adapted to afford security to its eggs, and proper nourishment for its young, it lays, just when the small birds themselves begin to lay, a single egg in each, till it has produced its appropriate number, as if aware of the consequences that would ensue, were two or more eggs deposited in the same nest.

Having, in this hasty sketch, shewn that the instinctiveness of the most remarkable propensities of the cuckoo admits of direct

proof, it follows, that the notion of the peculiarities of this extraordinary bird being acquired must be relinquished as quite untenable.

I am unwilling to trespass further on the patience of the Society, or I might indulge in numerous interesting reflections that naturally arise out of the subject before me. I must, however, be allowed to observe, in conclusion, that the history of the cuckoo, by the evident marks of design which it displays in the admirable adaption of means to ends, affords a most convincing proof of the existence of a "Great First Cause," the mysterious source of all that is good and beautiful in nature.

OBSERVATIONS
ON THE
ARMORIAL BEARING
OF THE
Town of Manchester,
AND ON
THE DESCENT OF THE BARONIAL FAMILY
OF
GRELLY.

BY WILLIAM ROBERT WHATTON, F. A. S.

(Read before the Society, Feb. 20th, 1824.)

IN soliciting the attention of the Society to the consideration of a question purely genealogical, it is not pretended to offer a point of any great difficulty, or to discuss a matter of much real importance. It is a subject in which the Antiquary and Herald, accustomed to pore over the dusty records of times gone by, are infinitely more interested than the Politician, the Critic, or the Philosopher.

I am desirous, however, that the Armorial Bearing of a town of such consequence in the British dominions, as Manchester con-

fessedly is, should be in some way explained and accounted for, and that we should no longer doubt, that in antiquity as to the origin of its Bearing, as well as in legitimacy as to right, it takes rank with the greatest cities and oldest boroughs in the kingdom.

The Arms of Manchester are Gules, three Bendlets enhanced Or, and have usually been attributed to a branch of the ancient family of GRESLEY of Derbyshire, which has been seated in that County, and has enjoyed the same property, by grant, from the Conquest until the present time, and is now represented by Sir Roger Gresley, Baronet, of Drakelow.

Guillim, Collins, Banks, Lysons, and others, with little difference, say, that the origin of the family, denominated from the MANOR of GRESLEY, anciently written GRESELE, GRESELEI, GRESLEA, and GRISLY, &c., is derived from MALAHULCIUS, uncle to Rollo, Duke of Normandy, from whom descended ROGER de TOENY, Standard-bearer of Normandy, whose younger sons, Robert and Nigel, accompanied the Conqueror to England. ROBERT, at the time of the general survey, possessed near a hundred and fifty Lordships, and fixing his residence at Stafford thence surnamed himself, and was ancestor of the no-

ble house of the Staffords, of which, Humphrey was created Duke of Buckingham by Henry VI. with precedency before all Dukes, the Blood Royal excepted: and from which sprung a race long eminent in the rank of Barons, Earls, and Dukes of the Realm. NIGEL, the other son, held DRAKELOW, and eleven other Lordships in Derbyshire, as appears by Domesday Book; and was the direct ancestor of the family of GRESLEY, still possessing that Lordship.

WILLIAM, the son of NIGEL, founded the Monastery of Gresley, of which little or no trace now remains.

ROBERT de GRESLEY, son and heir of this WILLIAM, founded an Abbey for Cistertian Monks at Swineshead, in the county of Lincoln, and from him descended the GRESLEYS, Lords of Manchester, who had summons to Parliament among the Barons of the Realm: whereof Thomas Gresley had summons from the first to the fourth year of the reign of Edward II. inclusive, and died without issue. His sister Jane married John, son of Roger de la Warre, and brought a fair inheritance to that noble family, from whom the present Earl de la Warre is descended.

WILLIAM de GRESLEY, of DRAKELOW, brother of the second Robert, had issue Sir Geoffrey de Gresley, ancestor of the line of Baronets now living there.

Mr. Blore, in contradiction to this account, in his History of the County of Rutland, has expressed an opinion that the Lords of Manchester may be a branch of the ancient house of Grulli, in the south of France, on the borders of the Lake of Geneva, of which was Sir John de Greilly, Knight, on whom Prince Edward, eldest son of King Henry III. in the forty fourth year of his father's reign, conferred considerable possessions in Provence, and whose descendant, Sir John de Grailly, Captain de Buch, was one of the most eminent warriors who served under Edward III. in his wars with France, and one of the first Knights of the Garter.

On looking to Ashmole, however, I find the arms of this Sir John de Grailly to be Or, on a Cross Sable, five Escallops Argent.

If there be any probability in this idea, which to me seems totally inadmissible, the connection must be at least as remote as the Conquest, and will offer no reasonable ground of objection against what I have to say on the subject.

That the GRELLEYS, Lords of Manchester, are descended from the GRESLEYS of DERBYSHIRE, (which impression has originated from the accidental resemblance of the surname, and has apparently been sanctioned by the coincidence of there having been actually existing in the reign of Henry III. a Robert Grelley of Lancashire, and a Robert Gresley of the county of Derby) I shall endeavour to prove incorrect, for the following reasons.

I. That their origin and descent have no relation whatever to the Derbyshire family.

II. That the Armorial Bearing of each family is widely distinct, as now used by their existing representatives.

III. I cannot find that the GRESLEYS held at any time any Manors or Estates in the county of Lancaster.

When William, Duke of Normandy, undertook the conquest of this country, it was stipulated that the warriors, who afforded their assistance, should partake in the spoil, and that the Saxon lands should be divided among them according to the respective rank of the parties, and the nature and extent of the service each severally rendered.

On this division, the share which fell to Roger of Poictiers, one of William's soldiers, commonly styled in the Domesday survey, Rogerus Pictavensis, afterwards Earl of Lancaster, was immense. The whole of the lands lying between the rivers Ribble and Mersey, with the hundreds of Amounderness, Furness, and Lonsdale, in this county, were given him, to be held of the King in capite, and not less than fifty manors in the county of York, thirty-two in the county of Lincoln, five in Derbyshire, and three in the county of Nottingham, with many other grants, by which he obtained vassals, borders, villains, and sokemen, with oxen for plough and draught, mills, fisheries, woods, meadows, &c.

Roger's associates in the war were, in like manner, paid for their services under his banner by re-grants of these manors, to be held of him by different tenures, mostly, however, by knight-service, and that of finding troops for his and the King's use.

Among these I observe one ALBERT GRESLET, who was rewarded by Pictavensis with lands in the counties of Norfolk, (*a*)

(*a*) Spikesuuard ten. Albt. quam ten. Suart. lib. hom. sub Heraldo.
LIB. DOMESD. for NORFOLK.

Lincoln, and Nottingham, (*b*) and, in conjunction with Roger Busli, (another General under the same banner,) with the hundred of Blackburnshire, (*c*) in this county, and who fixed his residence in that neighbourhood: for, on a division of their joint possessions afterwards, Greslet had part of Leyland (*d*) hundred, formerly granted to Busli,) in exchange for lands in Blackburnshire, consisting of the several manors of Gogard, (*e*) Adlington, Duxbury, Brindle, Worthington, and Coppull; and a Knight's fee in Dalton, Wrightington, and Parbold. He also occurs as a witness to a charter of Earl Roger Pictavensis, made to our Lady of Lancaster, in the reign of William II.

This Albert is erroneously termed by Dr. Kuerden, the *first* Baron of Manchester. (*f*)

(*b*) Thoroton's History of the Co. of Nottingham, under COTGRAVE.

(*c*) INT. RIPA. ET MERSHA.

IN BLACKBURN. HUND.

Tot. ſſt cu. Hund. reddeb. Regi de firma XXXII lib. et II solid. Hanc tra. tota. ded. Rogerius Pictavensis Rogerio de Busli et Albto Gresle, et ibi sunt tot hoes qui hnt XI car. et dimid. quos ipsi ccessor, ee qetos usq. ad iij anpos et ido n. appciat. m.

LIB. DOMESD. FOR LANC.

(*d*) Kuerden's MSS. in the Chetham College Library, and Kenion's MSS. of the Barons of Lancashire, in the possession of Holland Watson. Esq. of Congleton.

(*e*) I cannot precisely ascertain this place in Leyland Hundred.

(*f*) Kuerden's MS. loco citat.

To him succeeded his son ROBERT, also improperly denominated by Kuerden the *second* Baron, who founded a Monastery for Monks of the Cistertian order at Swineshead, (*g*) in the county of Lincoln, which property was likewise held of Pictavensis, in like manner as in Lancashire.

To this Monastery Henry II. by charter in the twelfth year of his reign, confirmed the several possessions the Monks had received of the gift of the said Robert Grelley and Albert his son, co-founders of the said Monastery. (*h*)

(*g*) Monast. Anglic. Vol. 1. p. 608 and 773. Blore's Hist. of Rutland. Part 2. p. 94.

(*h*) That other part of the town (of Cotgrave,) which was of the fee of Roger Pictavensis, it seems, was given to Swineshead, in the county of Lincoln.

King Henry II. in the twelfth year of his reign, confirmed to the Monks of Swineshead the whole land of Robert de Gresley in Cotgrave, and the moiety of the Church there, and one carucate of land in Cotgrave, of the gift of Robert de Archis, and whatsoever Robert de Gresley and Albert his son, the founders, gave to the said Church of Swineshead—fourteen acres which Robert Rossal gave—and the exchanges which Roger de Burun and his men (i. e. those who held of him) made with the said Monks, and likewise of the gift of William de Villars and Paganus his son, of two and a half carucates and two bovats and a half in Newbold; and of Elias Fancourt, of twelve bovats of the same territory.—(*Chart. Antiq. Y. 12 Hen. II;*) Robert Grelle gave one bovat, of his fee in Cotgrave, to the Church of Lenton, to which Ralph, his Priest of Cotgrave, was witness.—(*Reg. de Lenton, fo.* 83.) Maurice de Creoun, in the twenty-eight year of Henry II. gave account of two hundred marks, for having the wife, who was Albert Gresle's, with her rea-

Down to this Robert, there certainly was no connection whatever between the GRELLEY family and the MANOR of MANCHESTER, excepting a gift "in eleemosyna," to the Church from his demesne lands; though Sir William Dugdale, in the Baronagium, Vol. I. p. 608, expressly says "that he was the first that possessed the Manor, where he had his principal seat." He was living in the thirty-fifth year of Henry I.

ALBERT, First Lord of Manchester, Kuerden's *third* Baron, son and heir of Robert, married Agnes, one of the daughters of William Fitz Nigel, Baron of Halton and Widnes, and Constable of Chester, and one of the sisters and co-heirs of William Fitz Nigel the younger, also Baron of Halton and Widnes, and Constable of Chester; by which marriage the Barony of Manchester was inherited by his descendants: for, by the book of Domesday,

sonable dower.—(*Rot. Pip.* 28 *Hen. II. Linc.*) Wido de Creoun, in the first year of Richard I. ought £7. 6s. 8d. for the very same.—(*Rot. Pip. I. Rich. I. Linc.*) Gilbert Basset, and Alan and Thomas, his brothers, in the second year of Richard I. gave account of five hundred and fifty marks, for the custody of the son of Albert Gresle, with his heir and land.—(*Rot. Pip.* 2 *Rich. I. Linc.*) Albert Gresle had one son and three daughters, and their uncle Gilbert Basset, with his father, Thomas Basset, had the keeping of them about the thirty-third year of Henry II.—(*Rot. de Dom. Pasc. et Pasch. in mat. Dom. Reg. in Scac.—rot.* 1 *Linc. et. rot.* 5 *Nerf.*)

THOROTON'S NOTTS. I. 167.

it appears that, at the time of the Conqueror's survey, Nigel was the most considerable owner in the hundred of Salford, situate between the Ribble and Mersey, of which MAMCESTRE was parcel. (*i*)

By the Testa de Nevil, it also appears that Roger de Lacy, descended from Eustace Fitz John, and Matilda, the other sister and co-heir of William Fitz Nigel the younger, held four Knight's fees of the Constable's barony, in the same hundred.

This ALBERT GRELLEY (*j*) enfeoffed Orme, son of Ailward, in marriage with his daughter Emma, of one Knight's fee in Dalton, Parbold, and Wrightington, and one carucate of land in Ashton; which Orme was progenitor of the Ashtons of Lancashire.

He was succeeded by ALBERT, his son and heir, Second Lord of Manchester, (*k*) styled

(*i*) Dugdale's Monast. Vol. I. 188.
BLORE'S RUTLAND. p 94.
SALFORD HUNDRED.
De hac tra. huj. Maner. tenent Milites Rogerii Pictavensis. Nigellus 3 hidas et dimid. carucat. tre. &c.
LIB. DOMESD. p. 270.

(*j*) Albert Gredle senex dedit 1 fœd. mil. Ormo fil. Ailward. in maritagio c. Ema filia sua in Dalton. Perbold. et Writinton. et prædict Orm. tenet prædict. tram. Id. Alb. ded. dicto Orm. fil. Ailw. c. fil. sua Ema in maritagio 1 car. tre in Eston pro X solid.—et hered. ejusd. Orm. modo t. illam.
TEST. DE NEV. LANC. fo. 823. and KUERD. MSS. LOCO CITAT.

(*k*) Omitted altogether by Kuerden.

in divers records, Albertus *juvenis*, (*l*) to distinguish him from his father, who was called Albertus *senex*.

This Albertus juvenis was dead in the twenty-eighth year of Henry II. (1182) (*m*) leaving his wife, Isabel, (*n*) daughter of Thomas Basset, and afterwards the wife of Guy de Creoun, surviving him.

By Isabel Basset he had a son and heir, ROBERT, Third Lord of Manchester, (*o*) who was eleven years old, in the thirty-second year of Henry II. (1186,) and then under the guardianship of Gilbert Basset, his uncle, (son of Thomas Basset,) and of his mother, then the wife of Guy de Creoun, still living. In the sixth year of Richard I. this Robert was of age, (*p*) and attended that Sovereign in his expedition to Normandy, having thereupon had scutage of his tenants in Lancashire; and in the third year of King John, upon

(*l*) Test de Nevil. and Blore's Rutland.

(*m*) Rot. Pip. 3 John, Lanc.

(*n*) Sir Will. Dugdale and, after him, Dr. Kuerden state th Isabel Basset was the second wife of the first Albert; but in this they are evidently mistaken, and must either have confounded the two Alberts, or omitted one of them.

(*o*) Dr. Keurden's *fourth* Baron.

(*p*) Rot. de Dom. &c. Linc. rot. 1. and Norfolk rot. 5.—Banks' Extinct Peerage.—Dugd. Bar.—and Kuerd. MSS.

collection of the scutage of Normandy, paid twenty-four marks for twelve knights' fees he held within Lancashire and without. In the latter end of the reign of King John, taking part with the rebellious Barons, his lands were seized; but in the second year of Henry III. on making his peace with the King, he had restoration. His estates lay in the counties of Oxford, Rutland, Lincoln, Lancaster, Norfolk, and Suffolk. He married a daughter of Henry, brother of William de Longchamp, (q) Chancellor to King Richard, with whom he had the Lordships of Moslingham and Weston, in the county of Norfolk. In the sixth year of Henry III. he gave five marks and one palfrey for a charter for a fair at his LORDSHIP of MAINCHESTRE, to be held for two days, until the King should be of age; and in the eleventh year of that reign, this charter was confirmed by another, (r) granting a fair for three days, yearly, on the eve, on the feast of St. Matthew, and on the next day. Copies of these charters are lodged in the town's chest, and are in custody of the Boroughreeve for the time being.

He died in the fifteenth year of Henry III.

(q) Dug. Bar.---Blore's Rutland.---and Kuerd. MSS.

(r) Vide APPENDIX.—No. 1 and 2.

and left issue, THOMAS GRELLEY, Fourth Lord of Manchester, (*s*) his son and heir, who performed his homage, and had livery of his lands that same year. (*t*) In the twenty-sixth year of Henry III. he had summons to fit himself with horse and arms to attend the King in his expedition into France, whereupon he gave one hundred marks, besides his ordinary scutage, to be excused from that duty. In the twenty-seventh year of Henry III. being on the King's service beyond seas, he was quit of his castle guard in the Castle of Lancaster; and in the forty-second year of that reign, was ordered to attend the King to Chester, to withstand the incursions of the Welsh. In the forty-third year of Henry III. he was made Warden of the King's forests south of Trent, and died about the forty-sixth (*u*) of that reign; in which year it was found by inquisition that he, then lately deceased, had not enfeoffed PETER GRELLEY, his son, of the MANOR of MANCHESTER, and that, because it was held of the King in capite by barony, it was taken into the King's hands. The Sheriff had command to seize it, and

(*s*) According to Kuerden the *fifth* Baron.

(*t*) Rot. fin. 15 Hen. 3. m. 6.

(*u*) Rot. Fin. 46 Hen. III. m 12.

custody was granted to Edmund of Lancaster until the full age of Robert Grelley, (*v*) grandson and heir of the said Thomas.

ROBERT GRELLEY, Fifth Lord of Manchester, (*w*) grandson and heir of THOMAS, in the eighth year of Edward I. having married Hawise, daughter and co-heir of John de Burgh, son of John, son of Hubert de Burgh, sometime Earl of Kent, and having performed homage, had livery of the lands and manors of Wakerly in the county of Northampton, Kingston in the county of Somerset, and Portslade in the county of Sussex, as her share of her father's property. (*x*) At the entreaty of Henry de Lacy, Earl of Lincoln, and Robert Hamelle, Abbot of Stanley, he gave to that abbey lands in Westwood, in the township of Barton; the Abbot to perform the usual services appurtenant thereto, and to find wood to him and his heirs; and, upon the death or removal of the Abbot, relief, as if Robert Byram, the tenant, had held the same. (*y*)

(*v*) Escheat. 56 Hen. III m. 6.

(*w*) Seventh Baron according to Kuerden, who reckons his father PETER GRELLEY 6th Baron; which Peter apparently never inherited, but died early, leaving a son who succeeded his grandfather Thomas, fourth Lord.

(*x*) Rot. Fin. 8. Ed. I. m. 11. and Claus. 10 Ed. I. in dorso, m. 5.

(*y*) Kuerden's MSS.

This ROBERT was dead in the tenth of Edward I. whereupon Amadeus de Saucy had custody of the MANOR of MANCHESTER, during the minority of his son and heir, THOMAS GRELLEY, Sixth Lord of Manchester, (*z*) who, in the thirty-fourth year of Edward I. was made a Knight of the Bath, by bathing and other ceremonies; (*a*) and was summoned to parliament as a Baron, by writ, dated the 10th of March, in the first of Edward II. (1307), and returnable in fifteen days of Easter then following; which was the third parliament of Edward II. He granted a charter to the town of MANCHESTER, (*b*) constituting it a free borough, and continued to be summoned the fourth of that reign inclusive; (*c*) and probably died soon after, for, in the ninth year, John de la Warre, who had married Jane, sister and heir of this Thomas, was returned (*d*) Seventh Lord of Manchester, (*e*) in the county of Lancaster, of Swineshead and Great Casterton in the county of

(*z*) Kuerden's eighth Baron.

(*a*) Compot. Joh. de Drokensford Cust. Gard. in Scacc.---Blores' Rutland. p. 94.

(*b*) Vide APPENDIX.---No 3.

(*c*) Rot. Claus. iisdem annis.---Blore's Rutland.

(*d*) Ninth, according to Kuerden.

(*e*) Nom. Villar. in Scaccar.

Lincoln, of Wakerley in the county of Northampton, and of other possessions belonging to the family.

The estates of the GRELLEYS passed to the family of LORD de la WARRE, by this marriage with the heir, and thence again by marriage to the Wests; and the MANOR of MANCHESTER was sold by Sir Reginald West, in 1577, to Sir John Lacy, Knight, who conveyed it to Sir Nicholas Mosley, Lord Mayor of London. It is now the inheritance of SIR OSWALD MOSLEY, the present Baronet.

To prove that the identical ALBERT GRELLEY, mentioned in the Domesday survey, was the progenitor of the ancient race of the Lords of Manchester, and not NIGEL, son of the standard-bearer, and ancestor of the GRESLEYS of DERBYSHIRE, I would notice the descent of those manors, which fell to his share on the division of Blackburnshire and Leylandshire, held conjointly with Busli; of the lands in the counties of Lincoln and Norfolk, to the different branches of the family; and of part afterwards, through the heir, to the LORDS de la WARRE.

Among the many and various records and notices relating to the GRELLEYS, besides the proof of the descent of lands to the Ashtons

before cited, it is notified, in the Testa de Nevil for this County, fo. 791, that William de Worthington held half a Knight's fee in Worthington, of the fee of THOMAS GRELLEY, that Robert de Latham held a Knight's fee in Childwall, and a fourth part of one in Wrightington, of the fee of the said THOMAS; and, in an Inquisitio post mortem, of the tenth year of Edward I. that ROBERT GRELLY was found to have died seized of lands in Casterton in the county of Rutland; of the manor of Tunstead, and the advowson of the church; of Spikesworth, Henton, and Ilkeshale in the county of Norfolk; of Blackham Parva, Riseby, Wylesham, and Almesburne, appurtenant to the manor of Wylesham, all in the county of Suffolk; of Wrightington, Pilkington, Worthington, Copphull, Childwall, and the advowson of the church; of MANCHESTER, and the advowson of the church; and of the advowson of the church of Ashton, appurtenant to the MANOR of MANCHESTER, all in the county of Lancaster; of Casthorp, Swineshead, and the church of Wiketoft, appurtenant to the manor of Sixhill, of Heynton near Sixhill, of Bekeby, Bernetheby, Bracebrigge, and Chanwick, appurtenant to the manor of Sixhill, all in the county of Lincoln; of Stoneydelve, Cleyore, Goldore, Piriton

and the church; and of Pushull, appurtenant to the manor of Piriton, all in the county of Oxford.(*f*)

Of these estates, SPIKESWORTH in the county of Norfolk, WORTHINGTON, COPPHULL, and WRIGHTINGTON, in the county of Lancaster, were enjoyed by this Albert in the time of William I. and held under Pictavensis, as has been before observed. So that there is no doubt of the fact, that these GRELLEYS were his true descendants; and the table of genealogy which accompanies these observations, compiled from, and supported by, original evidences, proves that there cannot be any connection between them and the GRESLEYS of the county of DERBY; while the Armorial Bearing of the TOWN of MANCHESTER—the Seals of the GRELLEY CHARTERS and Deeds—the Quarterings of the DE LA WARRE and WEST families, as set out by the authority of the College of Arms, by Guillim, Collins and Edmondson—and the Shields formerly and now existing on the walls of the parish Church—all join to shew clearly that the Coat, viz. Gules, three Bendlets enhanced Or, was mutually borne both by the LORD and the BARONY.

(*f*) Cal. Inq. post Mort. temp. Edw. 1. fo. 74.—Gregson's Fragments of Hist. of Lanc. fo. 279.

APPENDIX.

No. I.

Anno Regni Regis Hen. Tertii 6to. M. 3.

Lancastria. } ROBERTUS GRESLEI dat Domino Regi unum Palfredum pro habenda. una. feria. usque ad ætatem Domini Regis singulis annis apud Manerium suum de MAINCESTRE per duos dies duratura. scilicet in vigilia Sancti Mathai Apostoli et ipso die Sancti Mathai nisi feria illa &c. et mandatum est Vicecomiti Lancastriæ quod capiat &c.—Teste Huberto &c apud Leukenor XI. die Augusti.

No. II.

Anno Regni Regis. Hen. Tertii undecimo. M. 4.

Pro Roberto Gresley. } H. REX &c. Salutem sciatis nos concecisse et hac presenti carta nostra confirmasse ROBERTO GRESLAY quod ipse et hæredes sui habeant in perpetuum unam feriam apud Manerium suum de MAINCESTRIA singulis annis per tres dies duraturam videlicet

in vigilia et in die et in crastina Sancti Mathæi Apostoli ita tamen quod prædicta feria non sit ad nocumentum vicinarum feriarum ut in aliis cartis de feriis. Quare volumus et firmiter præcipimus quod prædictus Robertus et hæredes sui habeant in perpetuum prædictam feriam bene et in pace libere quiete et honorifice cum omnibus libertatibus et liberis consuetudinibus ad hujusmodi feriam pertinentibus. Hiis testibus H. de Burgo Comite Kantii Justiciario nostro: R. Comite Cornubiæ fratre nostro: Willielmo Comite Albermarliæ: Hugone de Mortuo Mari: Briano de Insula: Phillippo de Albiniaco: Radulpho Gernon: Ricardo de Argentine et aliis. Datum per manum Venerabilis Patris Radulphi Cicestriæ Episcopi Cancellarii nostri apud Farendon nono decimo die Augusti anno Regni nostri XI.

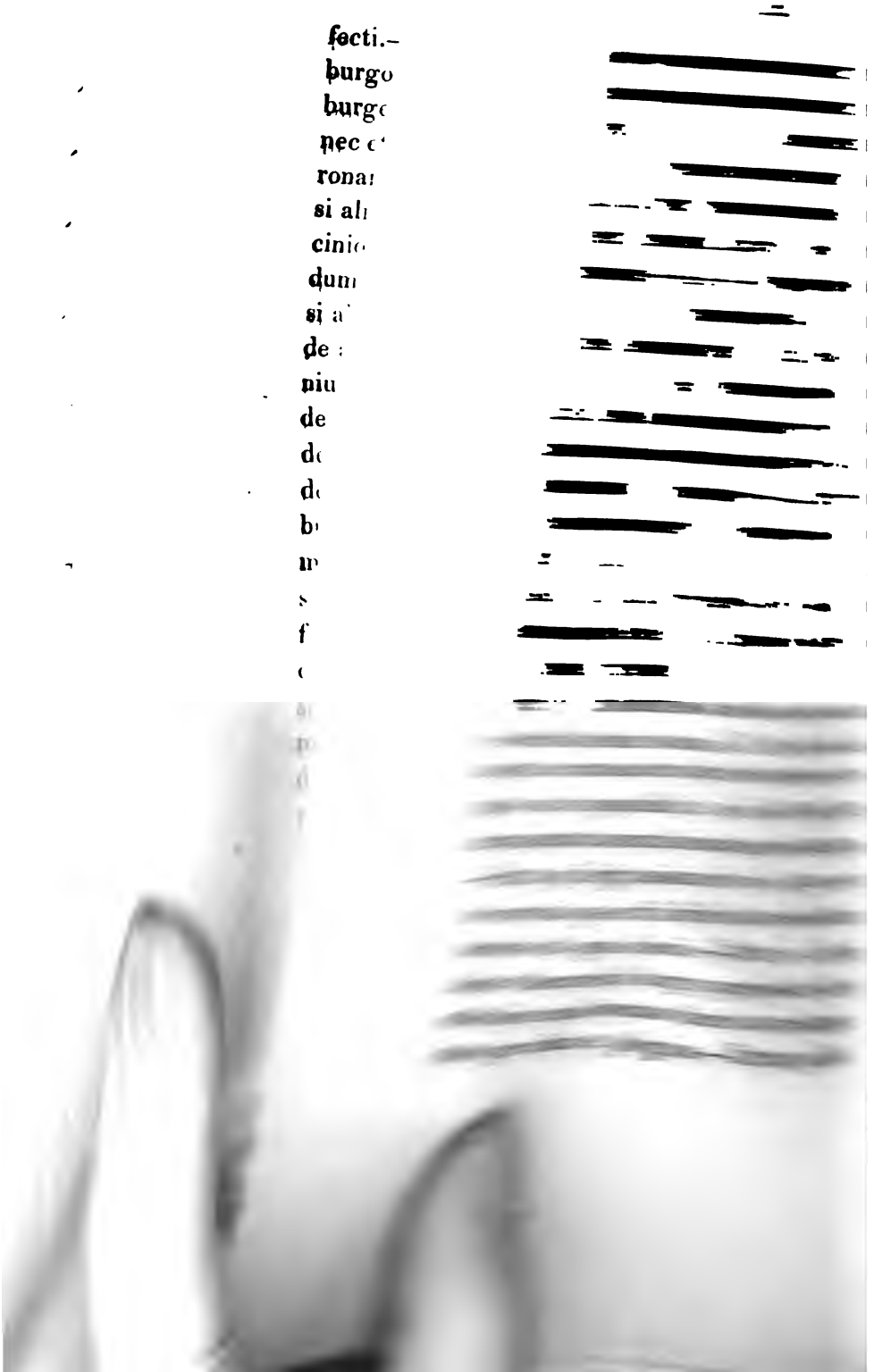
No. III.

Sciant presentes et futuri quod ego THOMAS GRELLE dedi et concessi et hac presenti carta mea confirmavi omnibus burgensibus meis MANCESTRENSIS scill. Quod omnes burgenses reddent de quolibet burgagio suo duodecim denarios per annum pro omni servitio. Et si Præfectus Villæ aliquem burgensem calumpniaverit de aliquo placito et calumpni-

atus non venerit ad diem nec aliquis pro eo infra Laghmot in foris factura est de duodecim denarios prædicto domino et prædictus dominus habeat placitum suum super eum in Portemanmote.—ITEM si aliquis burgensis aliquem burgensem implacitaverit de aliquo debito et ipse cognoverit debitum præfectus ponat ei diem scill. octavum et si non venerit ad diem reddat duodecim denarios pro foris factura die prædicto domino et reddat debitum et præfecto octo denarios. Et si aliquis faciat clamorem de aliqua re et non invenerit vadium et plegios et postea velit dimittere clamorem sine foris factura erit.—ITEM si aliquis burgensis in burgo aliquem burgensem vulneraverit in die dominica vel a nona die Sabbati usque ad diem Lunæ erit in foris factura viginti solidos. Et si in die Lunæ vel in aliis diebus septimanæ vulneraverit aliquem ipse cadet in foris factura duodecim denarios versus prædictum dominum.—ITEM si aliquis burgensis cum aliquo certaverit et per iram eum percusserit sine sanguinis effusione et ad domum suam redire possit sine calumnia præfecti aut famulorum suorum liber erit de placito præpositi et si guerram alius cui commisit sustinere poterit bene potest fieri sin autem per consilium amicorum suorum cum eo pacem faciat et hoc sine foris factura præ-

fecti.—ITEM si aliquis implacitatus fuerit in burgo de aliquo placito non respondeat nec burgensi villano nisi in suo Portemanmote nec etiam vasori excepto placito quod ad coronam regis pertineat et de latrocinio.—ITEM si aliquis vocat aliquen burgensem de latrocinio præfectus attachiat eum ad respondendum in curia domini et stare indicio.—ITEM si aliquis implacitatus fuerit de vicino suo vel de aliquo et tres dies secutus fuerit si testimonium habuerit de præposito et de vicinus suis de Portemanmote quod adversarius suus defectus sit ad hos tres dies nullum postea det responsum et de placito illo.—ITEM burgenses prædicti sequentur molendinum domini prædicti et ejus furnum reddendo consuetudines prædicti molendini et prædicti furni et debent et solent.—ITEM burgenses debent et possunt præpositum eligere de seipsis quem voluerint et præpositum removere.—ITEM nullus potest vicinum suum ducere ad sacramentum nisi habeat sectam de aliquo clamore.—ITEM nullus potest aliquid recipere infra villam nisi per visum præpositi. —ITEM liceat cuilibet terram suam quæ non est hæreditate vendere vel dare si necessitas inciderit cuicunque voluerit nisi hæres eam emere voluerit sed hæres debet esse propinquior ad eam emendam.—ITEM quilibet po-

test vendere de hæreditate sua sive majus sive minus sive totum per consensum hæredis sui. Et si forsitan hæres voluerit tamen si necessitas inciderit licebit ei vendere de hæreditate sua de quacunque ætate hæres fuerit.—ITEM præpositus debet cuilibet tradere burgensi et censario sendas suas in foro et præpositus debet inde recipere unum denarium ad opus prædicti domini.—ITEM si burgensis vel censarius voluit stare in senda mercatoris ipse debet pacare prædicto domino quantumcunque extraneus et si stet in propria senda tunc nil datum prædicto domino.—ITEM burgenses possunt nutrire porcos suos prope nutritos in boscis domini exceptis forestis et parcis domini prædicti usque ad terminum pannagii et si velint ad prædictum terminum discedere liceat eis absque licentia domini et si velint moram facere ad terminum pannagii de pannagio satisfaciant prædicto domino.—ITEM si aliquis implacitatus fuerit ante dies Laghmot et tunc venerit oportet eum respondere et non debet se essoniare sine foris factura et si tunc primo implacitatus fuerit tunc habeat primum diem.—ITEM burgenses possunt namare homines sive milites sive sacerdotes sive clericos pro debitis suis si inventi fuerint in burgo.—ITEM si necessitas inciderit quod aliquis vendat burgagium suum ipse



debet et potest esse ad placitum pro sponsa sua et pro familia sua et sponsa cujuslibet potest firmam suam reddere præposito et placitum sequi pro sponso suo si ipse forsitan aliunde fuerit.—ITEM si aliquis villanus burgenses calumpniatus fuerit de aliquo burgenses non debent respondere ei nisi habuerit sectam de burgensibus vel aliis legalibus hominibus.—ITEM burgensis si non habuerit hæredem ipse poterit legare burgagium suum et catalla cum moritur ubicunque sibi placuerit salvo tamen domini servitio.—ITEM si aliquis burgensis moriatur sponsa ejus debet manere in domo et ibi habeat necessaria quamdiu voluerit esse sine marito et hæres cum illa et ex quo illa voluerit maritari ipsa decedet et hæres ut dominus ibi manebit.—ITEM si burgensis moriatur hæres ejus nullum aliud relevium dabit prædicto domino nisi alicujusmodi arma.—ITEM si burgensis vendat burgagium suum et velit a villa decedere dabit domino quatuor denarios et liber ibit ubicunque voluerit. Pretera omnia placita prædicta erunt determinata coram seneschallo per rotulationem clerici prædicti domini. Et omnes libertates prænominatas ego prædictus Thomas et hæredes mei tenebimus prædictis burgensibus et hæredibus suis in perpetuum salvo mihi et hæredibus meis rationabili tallagio

quando dominus Rex fecerit tallagium per liberos burgos suos per Angliam. Et ut hæc donatio et concessio rata sit et stabilis sigilii mei appositione hoc scriptum roboravi. Hiis testibus dominis: Johanne Byron: Ricardo Byron Militibus: Henrico de Trafford: Ric. de Hulton: Ad. de Prestwyche: Rogero de Pylkington: Galfro de Chaterton: Ric. de Moston: Johe de Prestwyche et aliis. Datum apud Mancestr. qnarto decimo die Maii anno domini millessimo tricentessimo primo et anno regni Regis Edwardi filii Henrici Regis vicessimo nono.

(L. S.)

Thomas Baron Grelley temp. Ed. 2.

Sir John de Grailly. K. G. t. Ed. 3.

Sir Roger Gresley Baronet. 1824

EXPERIMENTS
ON
THE ANALYSIS
OF SOME OF THE
Aëriform Compounds of Nitrogen.

BY WILLIAM HENRY, M. D. F. R. S. &c. &c.

(Read March 19th, 1824.)

1.—*The Analysis of Nitrous Oxide and Nitrous Gas.*

THE methods of analyzing nitrous oxide and nitrous gas, described in the following pages, derive any value they may possess, from their enabling us to demonstrate the composition of those gases, by processes which admit of being more quickly executed than the methods already in use, and which, at the same time, are capable of affording results approaching as nearly to perfect accuracy, as is consistent with the nature of such investigations. The decomposition of nitrous oxide may, indeed, be readily and expeditiously effected, in consequence of its forming a combustible mixture with hydrogen

gas, a property discovered by Dr. Priestley, but first applied to the purpose of its analysis by Sir H. Davy, in the course of his researches into the compounds of nitrogen.(*a*) In the experiments of that philosopher, the results, approaching most nearly to precision, were obtained by detonating nitrous oxide with rather more than an equal volume of hydrogen, viz. 39 measures of the former to 40 of the latter. Both gases were in this case decomposed; water was produced; no nitrous acid was formed; and a volume of nitrogen remained, which always a little exceeded that of the nitrous oxide decomposed, viz. in the proportion of about 41 to 39.

In the repetitions which I have frequently made of this experiment, a similar excess of the accruing nitrogen, over the volume of the nitrous oxide employed, has always been observed, and generally in about the same proportion. But according to the law regulating the combination of gaseous bodies with each other, which has been deduced by M. Gay Lussac from a great variety of examples, (*b*) all tending to shew, that gases unite in proportions as to volume, which are

(*a*) Davy's Researches, London 1800 p. 366.

(*b*) Mémoires de la Soc. d' Arcueil II. 207.

either equal, or simple multiples of each other, nitrous oxide ought to be constituted of *exactly* one volume of nitrogen and half a volume of oxygen condensed into the space of one volume; and those products should result from every careful decomposition of the gas in question. That they are not correctly obtained by the method which I have just alluded to, appears to be owing to sources of inaccuracy, necessarily connected with that mode of analysis. I was induced, therefore to try various other processes, among which there is one that may deserve to be made known, since it exhibits, in a very summary way, and by a single operation, the quantities of nitrogen and oxygen that enter into the constitution of nitrous oxide, with as much precision as, I believe, is attainable in the present state of gaseous analysis. This method consists in firing, by the electric spark, a mixture of nitrous oxide and carbonic oxide in due proportions. The nitrous oxide, which I employed, was obtained by the careful decomposition of nitrate of ammonia, and did not contain in 100 parts more than 3 parts of gas unabsorbable by well boiled water. The carbonic oxide was generated from recently ignited chalk and iron filings, and after having been

washed with caustic potash, appeared, from the results of its combustion with oxygen, to be contaminated with not more than 3 per cent of foreign gas, having the properties of nitrogen. Some nicety was found to be necessary in adjusting the proportions of the gases to each other, in order to obtain a perfect decomposition. When an excess of nitrous oxide was used, some free oxygen was always detected in the residue; and yet a slight redundancy of nitrous oxide appeared to be essential to the perfect combustion of the carbonic oxide. After firing the mixed gases, and removing the carbonic acid by liquid potash, I next determined the proportion of oxygen in the residue by commonly known methods, and considered the remainder as nitrogen gas. An example, taken from an experiment made with great care, will best illustrate the nature of the process.

Carbonic Oxide 25 measures = 24.25 pure + 0.75 azote.
Nitrous Oxide 26 do. = 25.25 pure + 0.75 do.

51

52 after combustion.

28 after potash; found to consist of 0.85 oxygen + 27.15 nitrogen.

In this case, the carbonic acid, from 24.25 real carbonic oxide was 24 measures.

The nitrogen was by experiment - -	27.15
By calculation it ought to have been, From the nitrous oxide 26	
Do. carbonic oxide .75 - - -	26.75
Difference.....	0.40

No person, I believe, who is much experienced in processes of this nature, will look for a nearer approach to accuracy, than in the results of the experiment which has been just described; for the carbonic acid falls short by only $\frac{1}{960}$ of the theoretical proportion; while the nitrogen exceeds that proportion by only $\frac{1}{660}$, and the oxygen by $\frac{1}{770}$. The experiment was several times repeated, with approximations fully as near as the above to those which the law of volumes would require.

When the object in view is solely or chiefly to determine the quantity of oxygen in nitrous oxide, there can be no source of fallacy in the use of a slight excess of carbonic oxide. For this purpose I made several experiments, which agreed so closely in their results, that it may be sufficient to particularize one of them as a specimen of the rest.

Carbonic oxide 21 measures.

Nitrous oxide 19 do. = 18.4 pure + 0.6 nitrogen.

40

40 after combustion.

21.5 after potash; containing no free oxy-
[gen.

In this case, the carbonic acid was 40 − 21.5 = 18.5, and therefore exceeded in volume the theoretical proportion (18.4) by only $\frac{1}{11.5}$, a deviation much within the limits of possible errors, arising either from the difficulty of measuring small quantities, or of ascertaining the purity of the nitrous oxide. We may, also, from this mode of operating, deduce the quantity of nitrogen, which exists as an element of nitrous oxide; for since 1 volume of carbonic acid results from the combustion of 1 volume of carbonic oxide, the residuary 21.5 measures must have contained 21 − 18.5 = 2.5 of carbonic oxide and nitrogen introduced by that gas, + 19 measures of nitrogen disengaged from the nitrous oxide.

The results of the experiments with an excess of carbonic oxide suggested to me a ready and correct method of *testing* the nitrous oxide, which had hitherto been a desideratum. The only test, before applicable to this purpose, was the amount, to which the gas is absorbed, when agitated with well-boiled water. But besides the uncertainty whether all the nitrous oxide be in this case condensed, the proportion of the unabsorbed residuum is subject to variation, from the quantity of other gases extricated from the water itself. Re-

duced to the form of a rule, the new method may be stated as follows: Let a given volume of nitrous oxide be exploded with a slight excess of carbonic oxide of known purity; for example, 110 or 115 measures of the latter to 100 of the former. Now as each volume of *real* nitrous oxide gives, under these circumstances, an equal volume of carbonic acid, we may impute whatever carbonic acid is deficient of that proportion to the mixture of so much nitrogen with the nitrous oxide. If, for example, using an excess of carbonic oxide, there should result, from 100 measures of nitrous oxide, only 95 of carbonic acid, we may safely consider the nitrous oxide to be contaminated with 5 per cent of nitrogen gas. A proportion of nitrous gas may, I am aware, be occasionally mixed with the nitrous oxide, but this may be easily discovered, and previously separated, by solution of green sulphate of iron.

Having determined the application of carbonic oxide to the analysis of nitrous oxide to be so easy and satisfactory, I had hoped that the same agent might have been employed in the analysis of nitrous gas, which, as is well known, does not form a combustible mixture with simple hydrogen gas.(c) But

(c) Davy's Researches, p. 136.

on trial, I could not, by any variation which I made in the proportions of the two gases, obtain a mixture combustible by electricity. I had recourse, therefore, to olefiant gas; but had nearly abandoned this method also as impracticable, on finding that the mixture could not be set on fire by a spark from the prime conductor of an electrical machine. The discharge, however, of a small Leyden jar, through a mixture of nitrous gas and olefiant gas, occasioned a vivid combustion, and both gases were entirely decomposed. The following experiment may be taken as an example.

Olefiant gas 6.5
Nitrous gas 46.5 = 45.1 pure + 1.4 nitrogen.

53.0
40 fired.
27 washed with potash.

In this case 40 − 27 = 13 measures of carbonic acid were formed, which are just double the volume of the olefiant gas. In the residuary 27 measures, I found 2.7 measures of free oxygen. But 6.5 measures of olefiant gas require for saturation 19.5 of oxygen, to which, adding the residuary 2.7, we have 22.2 measures of oxygen by experiment in 45.1 nitrous gas; while theory would require 22.55 or about $\frac{1}{64}$ more than was actually

obtained. Again, the residuary nitrogen was $27 - 2.7 = 24.3$; while from theory it should have been half the volume of the pure nitrous gas, viz. 22.55 + the impurity of the latter $1.4 = 23.95$. The actual proportion of nitrogen, therefore, exceeds the estimated by only $\frac{1}{70}$th.

It may be stated, then, in general terms, as the results of analyzing nitrous oxide and nitrous gas by the methods which have been described in this paper;

1stly.—That 1 volume of nitrous oxide is decomposed by 1 volume of carbonic oxide; and the products are 1 volume of carbonic acid and 1 volume of nitrogen. But to convert 1 volume of carbonic oxide into an equal volume of carbonic acid, half a volume of oxygen is required. Therefore 1 volume of nitrous oxide must be constituted of 1 volume of nitrogen + half a volume of oxygen in the space of 1 volume.

2dly.—That six volumes of nitrous gas require for perfect decomposition 1 volume of olefiant gas, and the gaseous products are 2 volumes of carbonic acid and three volumes of nitrogen. But to form two volumes of carbonic acid by the combustion of carbon, two volumes of oxygen are necessary; and one volume of oxygen is required to saturate

the two volumes of hydrogen existing in 1 volume of olefiant gas. The results of this experiment, therefore, confirm the analysis both of nitrous gas and olefiant gas by other methods; for the former gas must consist of equal volumes of nitrogen and oxygen gases not condensed in bulk; and 1 volume of olefiant gas must be constituted of 2 volumes of hydrogen + carbon sufficient for forming 2 volumes of carbonic acid.

2.—*Of the Analysis of Nitric Acid.*

THE evidence of the composition of nitric acid, on which the view, now most commonly taken of its constitution, is founded, is derived almost entirely from synthetic experiments. Sir H. Davy long ago stated(*d*) that 4 in volume of nitrous gas and 2 of oxygen gas, condensed in water, absorb 1 in volume of oxygen to become nitric acid. But 4 in volume of nitrous gas being equivalent to 2 of nitrogen and 2 of oxygen, the whole oxygen in nitric acid will be 5 volumes to 2 of nitrogen, or 2.5 volumes to one volume. The smallest proportion of nitrous gas, found

(*d*) Elements of Chem. Phil. p. 284.

by Mr. Dalton to unite with oxygen gas, viz. 13 nitrous to 10 oxygen, gives the ratio in volume of nitrogen to oxygen, in nitric acid, as 1 to 2.53.(*e*) M. Gay Lussac also, determined by the test of the red sulphate of manganese, which is deprived of colour by the nitrous but not by the nitric acid, that the latter acid only is generated when 134 measures of nitrous gas are made to combine with 100 of oxygen, proportions which indicate almost exactly 1 volume of nitrogen and 2.5 volumes of oxygen in nitric acid.(*f*)

But though the synthetic proofs rest on such high authorities, and all tend to the same point, yet it is desirable to confirm evidence of this nature by that of analysis, whenever it can be obtained; and the object appeared to M. Gay Lussac sufficiently important to induce him to seek for this additional proof in two different ways, viz. by the decomposition of nitrate of lead and also of nitrate of baryta, each without addition, at high temperatures. The results, however, for reasons which he has stated, (same work,

(*e*) New System, p. 328, 364.

(*f*) Ann. de Chim. et de Phys. i. 404.

p. 405) were not satisfactory. On again reading his memoir, it occurred to me that a more complete decomposition of nitrate of baryta would probably be obtained by exposing it to a sufficient heat, in a state of intimate mixture with charcoal; and that the elements of the nitric acid would be evolved in the state of carbonic acid and nitrogen gases, products which admit of being easily and exactly separated from each other.

In my first trials of this process, I failed from the employment of too little charcoal, in consequence of which much nitrous acid vapour passed over, and acted upon the mercury over which the gases were collected. After repeating the operation several times, with various proportions of the materials, I found that by using at least 1 part of charcoal to 2½ of the nitrate of baryta, nitrous acid vapour was no longer evolved. In an experiment made with great care, the barytic salt was finely pulverised, and exposed for a whole day, with surfaces frequently renewed, to a temperature of 212° Faht. It was then mixed with the powdered charcoal, which had been recently ignited in a close vessel, to expel any moisture it might contain, and which was still hot; and a portion of quartz in very small grains, equal in weight to the

nitrate, was added to prevent the deflagration from being too rapid. The mixture was put into a green glass tube of the diameter of a common quill, into the upper part of which, before bending it so that it might pass beneath the mercury of the trough, a known weight of iron wire coiled into a spiral form was introduced. Under this part of the tube a double row of burning spirit lamps with flat wicks was placed; and when the iron wire appeared red hot, the mixture at the bottom of the tube was heated by another lamp, at first moderately to expel any moisture, that might have been absorbed from the air while the tube was being filled, and then more strongly so as to set the mixture on fire. By slowly moving the flame of the lamp under that part of the tube which contained the mixture, from above downwards, the combustion spread gradually through the whole, and the gaseous products were not more rapidly evolved than was consistent with their being wholly collected. They proved to be more complicated than I expected; for not only carbonic acid and nitrogen were obtained, but nitrous gas, carbonic oxide, and a very small quantity of hydrogen, the last of which would indicate the presence of water in the

proportion of about 0.7 of a grain to 100 of the nitrate and the materials added to it.

In the tube there remained, besides charcoal, carbonate of baryta, with a very small quantity of that earth in its pure state, but no undecomposed nitrate. After separating the pure baryta by boiling water, the carbonate was dissolved out of the excess of charcoal by muriatic acid; the solution decomposed by sulphate of soda; and, from the quantity of sulphate of baryta, its equivalent in carbonate, and the quantity of carbonic acid in the latter compound, were determined.

The analysis of the mixture of gases was made with the greatest care, and was thrice repeated. Reckoning up the oxygen contained in all the different products, and the nitrogen both free and in the nitrous gas, the volume of the latter was found to be to that of the former as 7.9 to 19.85, or as 1 to 2.51; thereby fully confirming that view of the proportion of the elements of nitric acid, which had previously been derived from synthetic experiments.

If then nitrous oxide be taken as the binary combination, in which the elements, nitrogen and oxygen, exist atom to atom singly, two volumes of nitrogen will contain the same number of ultimate particles or atoms as one

volume of oxygen. And imagining the smallest possible volume of each of those gases, or a volume containing only a single atom, the ultimate volume of nitrogen will be double the ultimate volume of oxygen. Two measurable volumes of nitrogen, when chemically united with one of oxygen, or with two, three, or more volumes, will afford compounds of nitrogen and oxygen, in which the atoms will bear the proportion of one to one, or one to two, to three, or to more atoms. And as two volumes of nitrogen are, in nitric acid, combined with five of oxygen, that acid is justly considered as constituted of one atom of nitrogen, the relative weight of which is 14, and five atoms of oxygen weighing together 40.

3.—*Analysis of Ammonia.*

Another combination of nitrogen, the exact analysis of which is of great importance, from the connection of the results with the law of volumes, as well as with the atomic system, is that into which it enters with hydrogen. Only one compound of those two elements, viz. ammonia, has yet been discovered, the decomposition of which, when existing as a permanent gas over mercury, may, as is well known,

be necessary for perfect decomposition, in order to prevent the formation of nitrous acid vapour, which is always generated when the nitrous oxide is in excess. For example, 10 measures of ammonia were deflagrated with 12 or 13 of nitrous oxide, the full proportion of the latter being, if pure, 15 measures. All the oxygen of the nitrous oxide was transferred to the hydrogen of the ammonia, water was formed, and the whole nitrogen of both gases remained as the aëriform product, mixed with a small quantity of hydrogen gas, for the combustion of which the nitrous oxide had not supplied sufficient oxygen. This quantity of hydrogen being too small to form a combustible mixture, it was necessary to make an addition of that gas, and to employ, for the second combustion, more oxygen than was requisite to saturate the hydrogen added. The quantity of hydrogen, originally in the mixture, was thus easily determined, and, when added to the volume of pure nitrous oxide expended, the sum expressed the whole hydrogen of the alkali.

In this more summary method of analysis, results were obtained, which fully confirmed those established by electrical agency, all concurring to prove that ammonia affords, by decomposition, a quantity of nitrogen and hy-

into graduated tubes, filled with mercury, which had been heated in the same tubes and still remained hot. To prevent any ammoniacal gas from lodging beneath the surface of the quicksilver in the tube, the flame of a spirit lamp was passed slowly along the part containing mercury, a precaution which was shown not to have been unnecessary by the ascent of a few bubbles of gas.

In four experiments, conducted with a degree of caution, to which I am not aware that any thing could have been added, the volume of the ammoniacal gas was fully doubled. In the first, 44 measures became 88 +; in the second, 157 became 320; in the third, 60 became 122; and in the fourth, 120 became 240. The evolved gases, carefully analyzed by combustion with oxygen, were found in each case to consist of 1 volume of nitrogen and 3 volumes of hydrogen. I repeated, also, with the greatest attention, a process for analyzing ammonia, which, with various other methods capable of being more quickly executed than that of electrical analysis, I have described in the Philosophical Transactions for 1809. It consists in firing, by the electric spark, a mixture of the alkaline gas with nitrous oxide, the latter being employed in rather less proportion than would

be effected by subjecting it to a long continued succession of electrical sparks, or of discharges from a Leyden jar. This method, originally discovered by Dr. Priestley, has been employed by the late Count Berthollet, by Sir H. Davy, by Mr. Dalton, and by myself, with a view to the accurate analysis of the gas. The process, however, being one into which sources of error may easily be introduced, there is not so perfect an agreement, as might have been wished, among the results of different observers. Without entering into a detail of these discrepancies, or a statement of their causes, it may be sufficient to observe that the view of the constitution of ammonia, taken by M. Gay Lussac, represents it as consisting of 1 volume of nitrogen and 3 volumes of hydrogen condensed into the space of 2 volumes.

In order to satisfy myself on a point, the determination of which is so essential to a just view of the atomic constitution of the compounds of nitrogen, I have lately made fresh experiments on the decomposition of ammonia by electricity, using every precaution that occurred to me as likely to insure the accuracy of the results. The gas was collected over recently boiled and dry mercury, and was transferred for decomposition

drogen gases equivalent to twice its volume, and consisting of 1 volume of nitrogen and 3 of hydrogen. To preserve, however, an agreement between the theory of volumes and that of atoms, it is necessary rather to view ammonia as constituted of 2 volumes of nitrogen and six of hydrogen. For since 2 volumes of hydrogen unite with one of oxygen to form water, every ultimate volume of hydrogen, (on the supposition that water is constituted of an atom of each of its elements) must, like the ultimate volume of nitrogen, be double that of oxygen. Two appreciable volumes of nitrogen, and two of hydrogen, will contain then the same number of ultimate particles or atoms, and multiples of 2 in volume of either gas, will be multiples of the numbers of single atoms of hydrogen or nitrogen. It must be acknowledged to be remarkable that the only known compound of nitrogen and hydrogen should, according to this view, be constituted of one atom of the former element and three of the latter; and that, during the decomposition of ammonia by electricity, those elements, disunited from each other, should not recombine in new proportions, as happens to the elements constituting the aëriform compounds of nitrogen and oxygen, when subjected to the same decomposing influence.

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Note on Oil and Coal Gases.

Page 78. "Oil gas is better, volume for volume, than coal gas, by about 10 per cent."

This is supposing the value proportional to the oxygen required for their combustion, and that good average coal and oil gases require for every 100 about 170 and 190 oxygen respectively, as would result from Dr. Henry's experiments. I find the average of coal gas from the Manchester gas works requires very nearly 170 per cent. of oxygen; but the oil gas from Mr. Hoyle's works now (1824) usually requires about 225 oxygen. This brings the ratio of coal and oil gases, as 3 to 4.

From a recent train of experiments however I find that the *heat* from the combustion of these gases is accurately or very nearly in proportion to the oxygen consumed, and that whether the gases are diluted or not: but the *light* is nearly in the compound ratio of the oxygen consumed and the density of the combustible gas, *when this last is nearly pure;* but if it is diluted with any incombustible gas or even with hydrogen, the diminution of *light* is vastly greater than in proportion to the dilution. I find one cubic foot of oil gas (sp. gr. 0.9 $\pm$) equivalent to 2 or $2\frac{1}{4}$ of coal gas, (sp. gr. 0.6 $\pm$) for the purpose of illumination.

J. D.

July, 1824.

Printed by the Executors of S. Russell, Manchester.

ERRATA.

Page 81 line 11, for " 4 or 3," read " 4 to 3."

344 last line, &c. and page 345, line 13, for g and g', read g and g'.

251 line 1, &c. *dele* " or that of the compression to the extension of the external fibres, (since the compressions and extensions are here as the forces.)"

259 line 4, for the divisor 50, read 60.

265 line 12, for 9 the denominator, read 5.

280 line 9, for .97, read =.97.

283 line 11, *dele* = g.

297 *et seq.* to 305, are omitted by the printer's mistake.

473 in the title, for Grelly, read Grelley.

N. B.—The separate table of birds is to face page 131.—The map of Troy is to face page 284.

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